Zentrum für Entwicklungsforschung

Sustainability of community forestry enterprises: indigenous wild honey gathering in the UNESCO Man and Biosphere Reserve Palawan, Philippines

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ABSTRACT

Commercialization of non-timber forest products has been one of the strategies worldwide for integrated rural poverty alleviation and forest conservation. Through a social-ecological systems approach, this dissertation aims to assess the contribution of a community forestry enterprise to sustainable rural development in an indigenous forest community in an ecological frontier. Specifically, this research work seeks to define the current relationship of indigenous Tagbanuas on Palawan island in the Philippines with giant honey bees (*Apis dorsata* Fab.) and analyze the impacts of a wild honey enterprise on rural livelihood, forest preservation, and traditional culture. By employing the multi-step knowledge development process of transdisciplinary research, this dissertation establishes system knowledge and target knowledge, which are both important in shaping transformative knowledge. This has the potential to influence local, regional, and global decision making processes on indigenous livelihood, forest and honey bee conservation.

In chapter two, a global review was conducted on the role of wild bees in social-ecological systems. The review shows that wild bees occupy a central role in social contexts and mostly provide services and benefits related to food, medicine, and pollination. Chapter three shows that on a local level, indigenous Tagbanuas mostly use honey for food, medicine, and material. The majority (94%) of 251 non-honey hunter Tagbanuas surveyed consume honey; however, most of them (86%) only use less than a liter of honey annually. Nowadays, honey hunters rarely perform hunting rituals and also sell beeswax, which had long been considered important in Tagbanua rituals. Despite wild honey hunting being a major livelihood activity, only 24% of those surveyed could correctly identify the giant honey bee. Inferential statistics show that lower level of education correlates with a higher probability to correctly identify the giant honey bee. Chapter four details how giant honey bee nesting areas were voluntarily mapped by honey hunters who trained in using global positioning system equipment. In chapter five, spatial analysis was conducted on nesting tree areas. Results show that vegetation cover dropped from 0.61 in the year 1988 to 0.41 in 2015. Pollen analysis showed the presence of at least 11 plant families in honey samples. This includes the mangrove family Rhizophoraceae, which hints that the giant honey bees forage in both terrestrial and coastal areas. A minority of community members responded that they use chemical fertilizers (4%) and pesticides (20%), which are known to be harmful to bees. However, the laboratory-analyzed honey samples contain no pesticide residues, showing the potential of Tagbanuas honey to be classified as organic. In chapter six, results of a gross margin and integrated value chain analysis show that downstream actors capture most of the economic value of wild honey. Commercial wild honey hunting may help avoid poverty aggravation, but it seems insufficient in alleviating poverty or guaranteeing conservation. In chapter seven, we discuss how integrated conservation and development projects have much potential in promoting sustainable development in indigenous forest communities but challenges

need to be overcome to fulfill this potential. Institutions must not only focus on provisioning ecosystem services of giant honey bees, but also consider cultural and regulating services. In pursuing sustainability and systems thinking, this dissertation compels readers to pay attention to two marginalized entities: indigenous groups and honey bees other than the well-known European honey bee (*A. mellifera* L.). In doing so, this research hopes to influence conservation and development efforts to become more inclusive and sensitive to entities left behind.

Nachhaltigkeit gemeinschaftlicher Forstbetriebe: Sammeln wilden Honigs durch Einheimische im UNESCO Mensch- und Biosphärenreservat Palawan, Philippinen

KURZFASSUNG

Die Kommerzialisierung von Nicht-Holz-Waldprodukten ist eine der Strategien der integrierten ländlichen Armutsbekämpfung und des Naturschutzes. Unter Nutzung eines sozial-ökologischen Systemansatzes zielt diese Arbeit darauf ab, den Beitrag gemeinschaftlicher Waldnutzung indigener Bevölkerungsgruppen zur nachhaltigen ländlichen Entwicklung zu beurteilen. Als Fallbeispiel dienen dabei die aktuellen Wechselwirkungen der indigenen Gruppe der Tagbanuas auf Palawan Insel in den Philippinen mit Riesen-Honigbienen (*Apis dorsata* Fab.) Dabei werden die Auswirkungen der kommerziellen Honigvermarktung auf die ländlichen Lebenswelten, den Schutz des Waldökosystems und die traditionelle Kultur zu analysieren. Durch den Einsatz eines mehrstufigen Wissensentwicklungsprozesses aus der transdisziplinären Forschung werden in dieser Arbeit Systemkenntnisse und Zielwissen geschaffen, die für die Gestaltung von transformativem Wissen wichtig sind. Sie können lokale, regionale und globale Entscheidungsprozesse auf die indigenen Lebenswelten, den Waldschutz und die Erhaltung von wilden Honigbienenpopulationen beeinflussen.

Eine globale Überprüfung der Rolle der Wildbienen in sozial-ökologischen Systemen zeigt, dass wilde Bienen eine zentrale Rolle in ruralen sozialen Kontexten einnehmen und Produkte und Dienstleistungen etwa in Form von Nahrung, Medizin und Bestäubung bieten. Indigene Tagbanuas nutzen Honig als Nahrung, Medizin und Material. Die große Mehrheit (94%) der nicht-Honig-sammelnden Tagbanuas verwenden Honig, allerdings die meisten von ihnen (86%) nur weniger als einen Liter Honig jährlich. Heutzutage führen Honigsammler selten Jagdrituale durch, und verkaufen stattdessen das Bienenwachs, das traditionell wichtig für Tagbanua-Rituale ist. Trotz des Sammelns wilden Honigs, was ein wichtiger Lebensunterhalt in Tagbanua-Gemeinden ist, konnten nur 24% von 251 nicht-Honig-sammelnden Tagbanuas die Riesen-Honigbiene richtig identifizieren. Inferentielle Statistiken zeigen, dass ein niedrigeres Bildungsniveau und eine höhere Vegetation die korrekte Identifizierung der Riesen-Honigbiene erheblich beeinflussen. Die Nistplätze der Riesen-Honigbienen wurden im Rahmen dieser Arbeit von den Honigsammlern mit Hilfe von globalen Positionierungssystemen (GPS) dargestellt. Die räumliche Analyse zeigte, dass die Vegetationsabdeckung in Nestbaumgebieten von 0,61 im Jahr 1988 auf 0,41 im Jahr 2015 sank. Die Pollenanalyse zeigte die Anwesenheit von mindestens 11 Pflanzenfamilien in Honigproben. Dazu gehört auch die Mangrovenfamilie Rhizophoraceae, die darauf hinweist, dass die Riesen-Honigbienen auch in küstennahen Gebieten Palawans Nahrung finden. Nur

eine Minderheit von Tagbanua Kleinbauern nutzen chemische Düngemittel (7%) und Pestizide (14%), die für Bienen schädlich sind. Die Honigproben enthalten keine Pestizidrückstände und zeigen ein Potential, das als organisch eingestuft werden kann.

Eine grobe Marge und eine integrierte Wertschöpfungskettenanalyse mit sozio-kulturellen Analysen zeigen, dass nachgeschaltete Akteure den größten Teil des ökonomischen Wertes von Wildhonig abschöpfen und die kommerzielle Sammlung von Wildhonig negative Auswirkungen auf die traditionelle Kultur von Tagbanuas hat. Kommerzielle Wildhonigsammlung kann dazu beitragen, ein weiteres Armutswachstum zu vermeiden, aber weniger dazu, Armut zu mindern. Integrierte Waldschutz- und Entwicklungsprojekte haben ein hohes Potenzial für die Förderung der nachhaltigen Entwicklung indigener Waldgemeinschaften. Allerdings gibt es Herausforderungen, die überwunden werden müssen, wenn dieses Potenzial umgesetzt werden soll. Institutionen müssen sich nicht nur auf die Bereitstellung von Ökosystemleistungen von Riesen-Honigbienen konzentrieren, sondern auch Kultur- und Regulierungs-Dienstleistungen berücksichtigen. Auf Basis des Nachhaltigkeitsdiskurses und eines Systemdenkens zwingt diese These die Leser, auf zwei marginalisierte ‚Einheiten' zu achten: indigene Gruppen und wilde Honigbienenarten abseits der bekannte Europäische Honigbiene (*A. mellifera* L.). Schlussfolgernd fordert diese Forschungsarbeit die bessere Integration von sensiblen Naturschutz- und Entwicklungsprogrammen im Globalen Süden.

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LIST OF ACRONYMS AND ABBREVIATIONS

A.	*Apis*
BAFS	Bureau of Agriculture and Fisheries Standards of DA
BAR	Bureau of Agricultural Research
BPS	Bureau of Product Standards of DTI
CBD	Convention on Biological Diversity
CFE	Community forestry enterprise
COP	Conference of the Parties
DA	Department of Agriculture of the Philippines
DENR	Department of Environment and Natural Resources of the Philippines
DTI	Department of Trade and Industry of the Philippines
EBC	Enterprise-based conservation
EC	European Commission
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration of the Philippines
FOB	Free on board
GIS	Geographic information systems
GM	Gross margin
GPS	Global positioning system
ICDP	Integrated conservation and development projects
IFAD	International Fund for Agricultural Development
IFOAM	International Federation of Organic Agriculture Movements
IHC	International Honey Commission
ILK	Indigenous and local knowledge
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPI	International Pollinators Initiative
IUCN	International Union for Conservation of Nature
MC	Moisture content
MEA	Millenium Ecosystem Assessment
NARTDI	National Apiculture Research, Training and Development Institute
NATRIPAL	*Nagkakaisang mga Tribu ng Palawan*
NCIP	National Commission on Indigenous Peoples
NDVI	Normalized difference vegetation index
NGO	Non-government organization
NTFPs	Non-timber forest products
NTFP-EP	Non-Timber Forest Products Exchange Programme
PFHN	Philippine Forest Honey Network
PGIS	Participatory geographic information systems
PGS	Participatory guarantee systems
PSA	Philippine Statistics Authority
RHmV	*Rückstands-Höchstsmengenverordnung*
SAKTAS	*Samahang Katutubong Tagbanua ng Sagpangan*

SLA	Sustainable livelihoods approach
SBSTA	Subsidiary Body on Scientific, Technical and Technological Advice
SDGs	Sustainable Development Goals
SES	Social-ecological system
SHS	Solar home system
TR	Total revenue
TVC	Total variable cost
UK IPI	United Kingdom Insect Pollinators Initiative
UN	United Nations
UNGA	United Nations General Assembly
UNICEF	United Nations Children's Fund
UNESCO	United Nations Educational, Scientific and Cultural Organization
USGS	United States Geological Survey
VCA	Value chain analysis
WHO	World Health Organization

1 Introduction

Conserving forest areas populated with local communities is not easily fulfilled through a protected area approach, which generally limits human presence and use of natural resources. This approach works under the assumption that there is a higher probability of conservation success in areas without any human activity compared to areas that also aim for community development and participation (Wilshusen et al. 2002). In indigenous community forests, this would require the relocation of indigenous communities who may have inhabited these areas for several generations. Alternative approaches have been sought to conserve forests while respecting human occupation by focusing on local use of forest resources except timber. Development organizations and local governments were quick to support integrated conservation-development projects (ICDPs) such as the development of community forestry enterprises (CFEs) focusing on non-timber forest products (NTFPs), which seemed to address dual objectives of forest conservation and rural development. After the initial enthusiasm, it became apparent that this approach has limited conservation and development gains, which can partly be attributed to a failure in realizing that conservation will always be undermined unless poverty is alleviated (Adams et al. 2004; Garnett et al. 2007; Shanley et al. 2015). In addition, poverty and conservation belong to different policy realms, which are difficult to integrate despite its seeming interdependencies: poverty reduction itself depends on the conservation of resources, but conservation must not compromise poverty reduction (Adams et al. 2004; Garnett et al. 2007).

Efforts integrating conservation and poverty alleviation through NTFPs continue especially in rural communities. NTFPs are important in rural livelihoods in developing countries, where 80% of its population use NTFPs for health and nutritional needs (Arnold and Perez 2001; FAO 2014a; Shackleton et al. 2015). When commercial value is added to NTFPs, it becomes a tool for market-based conservation (Peña 2010). This approach, also called enterprise-based conservation (EBC), focuses on increasing the economic incentive for conservation by setting up commercial activities based on biological resources available in an area (Lele et al. 2010). Even with varying levels of success, NTFP development remains an option in forest conservation efforts as a sustainable forest management strategy. On a global level, NTFP development has also been seen as having the potential to contribute to reaching the sustainable development goals (SDGs) on poverty, affordable and clean energy, sustainable cities and communities, and responsible consumption and production (FAO 2014b).

A lot of opportunities from NTFP development and ICDPs in general have been identified, but risks and threats to local stakeholders have been poorly recognized (Hughes and Flintan 2001; Bolwig et al. 2008). Implicit in ICDP design is the assumption that local stakeholders and their resource management approaches are the underlying causes of resource degradation and this has largely overlooked the role of external actors and forces in the success or failure of ICDPs (Hughes and Flintan 2001). As ICDPs continue to be part of local and international initiatives for forest communities, it is also necessary to continue assessing their results and move beyond a proof-of-concept phase to build an evidence base for sustainable rural development from ICDPs.

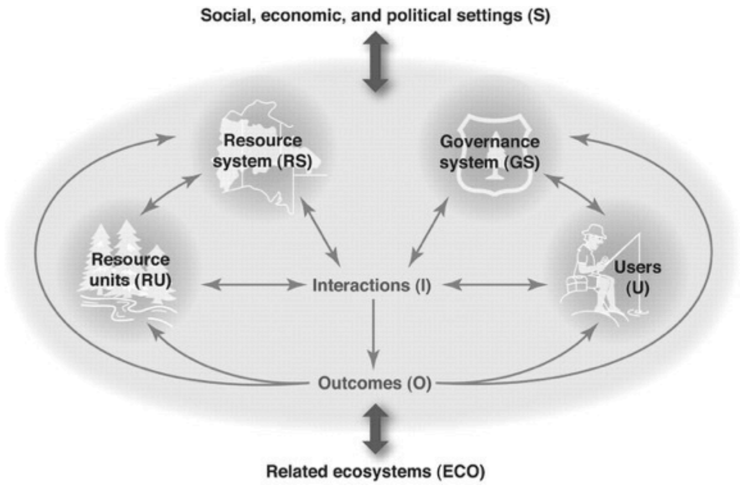

Figure 1.1 General framework for analyzing sustainability of social-ecological systems (Source: Ostrom 2009)

This dissertation sets out to assess the sustainability of a CFE designed as an ICDP for an indigenous group living in a biodiversity hotspot. The CFE exemplifies a social-ecological system (SES) where natural systems (environment) are linked to social systems (indigenous peoples). This dissertation recognizes that the main challenge in understanding the extent of sustainability in some SES may be due to the lack of identification and analysis of relationships among multiple levels and spatial-temporal scales within these systems (Ostrom 2009). Achieving the goal of sustainability involves many factors and it is, therefore, important to further integrate coupled human and natural components of a problem across multiple dimensions, including how one solution can create unintended consequences elsewhere (Liu et al. 2015). Ostrom's (2009) general framework for analyzing sustainability of SES (Figure 1.1) is useful in analyzing these multi-level and multi-scale relationships. In this dissertation, Ostrom's framework is used in assessing the ecological, economic, and socio-cultural sustainability of a wild honey CFE of indigenous peoples of Tagbanua ethnicity in Palawan, Philippines. To carry out this assessment, a transdisciplinary approach was necessary to actively involve stakeholders, practitioners, and other academic researchers from the conceptualization of the research up to the synthesis of the research findings.

1.1 Transdisciplinarity and the analysis of SES

The concept of SES emphasizes the integrated nature of social and ecological systems, leading to alternative terms such as coupled-human environment systems or coupled human and natural systems (Fischer et al. 2015). The traditional disciplinary divides in academia, however, have caused scientists to examine social systems and natural systems separately instead of looking at the linkages and feedbacks between the two (Berkes and Folke 2002). Studying the interaction between human and natural systems is a relatively new endeavor that has given rise to other analytical approaches and types of science (Gibbons et al. 1994; Funtowicz et al. 1999; Kates et al. 2001; Biggs et al. 2015). An example is sustainability science, which emerged as a new field to promote sustainable development and to understand the fundamental character of interactions between nature and society (Kates et al. 2001). In order to achieve its goals, sustainability science critically needs a new type of research collaboration that transcends disciplinary and interdisciplinary approaches (Lang et al. 2012). A transdisciplinary approach has, therefore, been seen as the most appropriate type of research collaboration in sustainability science (Lang et al. 2012; Angelstam et al. 2013). Despite a lack of common glossary or commonly shared research framework in transdisciplinary research, sustainability science commonly includes multiple disciplines aiming at solving societal and scientific problems through active engagement of stakeholders, practitioners, and researchers (Hirsch-Hadorn et al. 2006; Lang et al. 2012; Angelstam et al. 2013; Brandt et al. 2013). A transdisciplinary approach can facilitate adequate problem orientation and can ensure integrative results (Campennì 2016).

1.2 Achieving sustainability through integration of diverse knowledge types

Sustainable development, especially sustainable management of natural resources, draws from a broad range of knowledge – from western scientific knowledge to traditional (also referred to as indigenous or local) knowledge in order to identify inherent risks that can cause disruptions to SES (Rist and Dahdouh-Guebas 2006; Shiroyama et al. 2012).

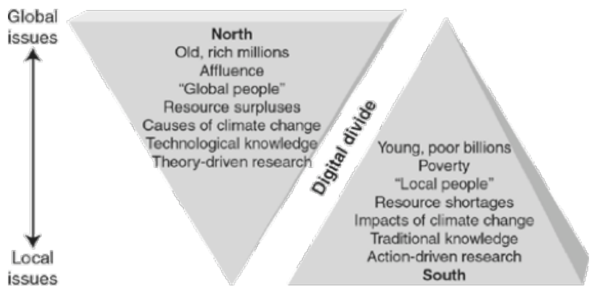

Figure 1.2 Different sustainability issues in the Global North and South (Source: Kates et al. 2001)

The road towards knowledge integration is paved with misconceptions that hinder effective interactions between different types of knowledge. Traditional knowledge is oftentimes referred to as "non-scientific," and, is therefore, seen as inferior compared to "scientific" knowledge derived from academic exercise (Rist and Dahdouh-Guebas 2006). On the other hand, scientific knowledge systems have received increasing criticism within the social science literature while indigenous knowledge systems are often over-optimistically presented as viable alternative ways of knowing (DeWalt 1994). Integrating these different types of knowledge not only provides checks and balances for the credibility of information, but also its legitimacy (Cash et al. 2002).

As shown in Figure 1.2, traditional knowledge and technological (commonly called scientific) knowledge are associated with the Global South and North, respectively. By using these two different types of knowledge to co-produce knowledge, it also bridges the "digital divide" between the Global North and South. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), for example, has recognized this by developing procedures to ensure that indigenous and local knowledge (ILK) are incorporated in all of its assessments (IPBES 2016a). This is not the first time that international institutions attempt to incorporate issues related to traditional knowledge or ILK (Agrawal 1995). It seems that "incorporating traditional knowledge or ILK" has become a staple phrase in most development initiatives since its promotion in the late '80s and early '90s (Agrawal 1995). However, merely "incorporating" these types of knowledge overlooks the process by which they were or are produced and this is important in identifying the proper use of knowledge. For example, local knowledge has less time depth than indigenous knowledge (Berkes and Folke 2002).

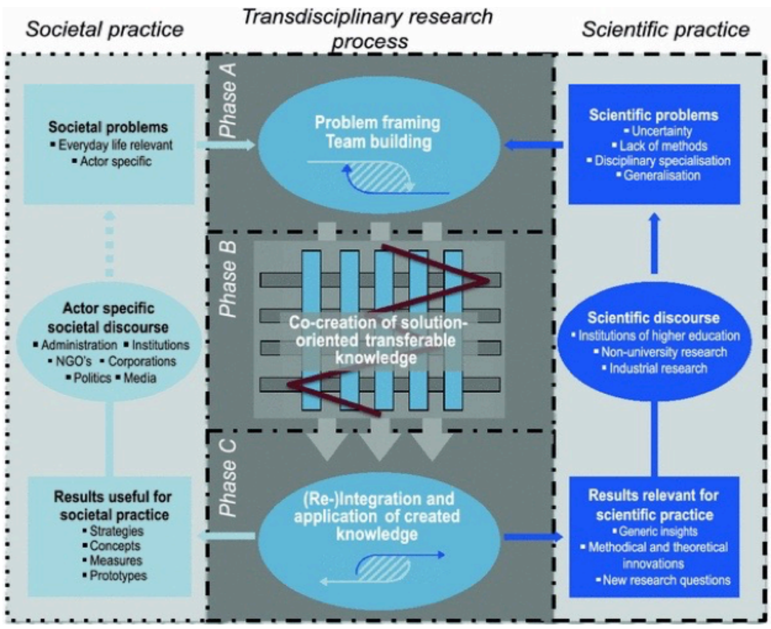

Figure 1.3 Conceptual model of an ideal-typical transdisciplinary research process. The transdisciplinary research process (Phase A, B, C) is a convergence of societal and scientific practice (Source: Lang et al. 2012)

Inaccurate conclusions might arise from confusing local knowledge with traditional ecological knowledge. Ideally, traditional knowledge or ILK holders should be involved at the very beginning of a development initiative or, in the academic realm, the research process. This corresponds to Phase A of Lang et al.'s (2012) ideal-typical conceptual model of a transdisciplinary research process (Figure 1.3), which has been adapted from previous studies. Collaborative problem framing and team building is important, not only for adequately identifying the problem but also for gaining trust of everyone involved. This is further discussed in Chapter 4, which shows how trust played a big role in knowledge co-production. This dissertation attempts to employ all phases of this transdisciplinary model and co-produce knowledge consistent with the three knowledge types presented by Brandt et al. (2013); these are system knowledge, target knowledge, and transformation knowledge. System knowledge refers to the current state of the system, target knowledge refers to future perspectives for the system, and transformation knowledge refers to practical implications that can change existing practices (Brandt et al. 2013).

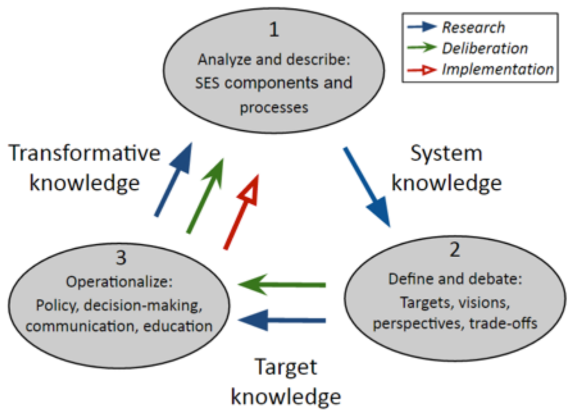

Figure 1.4 Multi-step knowledge development process. The generation of system, target, and transformative knowledge is possible through a transdisciplinary research process (Source: Partelow and Winkler 2016)

Partelow and Winkler (2016) arranged these knowledge types into a circular multi-step knowledge development process (Figure 1.4), stressing that research that can generate or orient all three types of knowledge remains elusive. This dissertation demonstrates that it is possible to generate these three types of knowledge through a transdisciplinary research process.

1.3 Scope of the dissertation

Following Lang et al.'s (2012) conceptual model of a transdisciplinary research process (Figure 1.3), problem framing and team building (Phase A) was implemented through field visits and discussions with the stakeholders, i.e., the Tagbanua wild honey hunter and gatherers and the organizations assisting them. This dissertation was shaped by the primary motivations of each stakeholder in engaging in the wild honey CFE: forest conservation, indigenous development, and sustainable livelihood opportunities. Several studies have proposed diverse solutions (for e.g. community-based natural resource management or, as previously mentioned, ICDPs), yet these challenges persist in forest communities perhaps due to lack of suitable research mechanisms during implementation or understanding of dynamic ecological and social interactions (Alpert 1996; Leach et al. 1999). This dissertation, thus, aims to evaluate the contributions and shortcomings of an

NTFP ICDP in addressing forest conservation (ecological), indigenous development (socio-cultural), and sustainable livelihood opportunities (economic). Given the substantial commitment of time and resources required to effectively research NTFPs, it would be necessary to prioritize research to focus on species that are (1) under threat, (2) identified by users to be of critical local and regional use, or (3) non-domesticated and involved in large-scale commercial trade (Shackleton et al. 2011a). Bulk of the wild honey harvest of the Tagbanua honey hunters and gatherers come from the giant honey bee (*Apis dorsata* Fabricius) (Hymenoptera: Apidae). Focusing on this species is not only relevant for ICDP and NTFP research, but also in biodiversity conservation and anthropological research. Honey hunting and gathering is not only a discrete economic activity, but also an indigenous socio-cultural practice (Novellino 2002). Anthropological work on the Tagbanuas, such as that of Venturello (1907) and Fox (1982), mention wild honey bee hunting and bee hive products as culturally important. Their use, existence, and cultural function in the Tagbanua tribe render the giant honey bees cultural keystone species (Cristancho and Vining 2004; Garibaldi and Turner 2004). Whether this still holds true today is further evaluated in this dissertation.

The global existence of bees is constantly under threat and, so far, only modest attention has been given to wild and feral honeybee populations (Moritz et al. 2005; Oldroyd and Nanork 2009). In the honey bee genus *Apis*, most scientific investigation has been done on only one species, the European honey bee (*A. mellifera* L.) (Oldroyd and Wongsiri 2006; Koeniger et al. 2010). While the European honey bee (also referred to as Western honey bee or managed honey bee) has been said to be the most important bee species to man due to their economic contribution, the importance of wild honey bee populations in other aspects cannot be overlooked (Southwick and Southwick 1992; Crane 1999; Morse and Calderone 2000; Allsopp et al. 2008; Jaffé et al. 2009; Garibaldi et al. 2013; Matias et al. 2017). Wild populations are "important reservoirs of local adaptations" that will decisively establish the survival of honeybees in nature (Matheson et al. 1996). Wild native bees pollinate native flora and these bees occupy keystone positions that can determine the eventual collapse of ecosystems or, as suggested by the concept of cultural keystone species, culture (O'Toole 2002). This dissertation makes a case for the importance of wild bees by establishing system knowledge not only on the economic but also ecological and cultural contributions of the giant honey bee.

1.3.1 Aim and objectives

In order to fulfill the aim of evaluating the contributions and shortcomings of a wild honey CFE as an ICDP, this dissertation has the following objectives addressing global and local scales as well as multiple types of knowledge:

a) Review ecosystem service benefits from wild bees across social contexts on a global scale;
b) Identify local ecosystem service benefits from giant honey bees in the Tagbanua community and analyze links with those of the global scale;

c) Characterize the habitat of giant honey bees and local management practices prior to and after CFE establishment;
d) Analyze social-ecological dynamics and feedback within the SES of giant honey bees in the Tagbanua community;
e) Assess profitability of commercializing wild honey vis-à-vis traditional gathering through an integrated value chain analysis; and
f) Examine the roles of relevant institutions and regulations in the wild honey CFE's fulfillment of its conservation and development goals.

1.3.2 Structure of the dissertation

Several frameworks such as Ostrom's (2009) SES framework or the Sustainable Livelihoods Approach (SLA) framework of Scoones (1999) are available for analyzing SES. The SLA can be used to analyze the wild honey CFE; however, it does not include dynamics of ecological systems and of SES nor does it include interactions within spatial scales and between SES compared to Ostrom's SES framework (Binder et al. 2013). While some may see Ostrom's SES framework as too generic, its strength lies in providing a frame, which can provide comparability of results due to its adjustable degree of specificity in its different tiers (Binder et al. 2013). This dissertation, therefore, uses Ostrom's SES framework to look at the SES dynamics within the wild honey CFE and between the spatial scales it is situated in.

The structure of this dissertation closely follows the three types of knowledge mentioned previously and illustrated on Figure 1.4, namely system knowledge (chapters 2, 3, and 4), target knowledge (chapters 5 and 6), and transformative knowledge (chapter 6). The analysis of system knowledge starts in chapter 2, where qualitative and quantitative review methods were used to analyze the role of wild bees in SES on a global scale (objective a). Chapter 3 shows the characteristics of honey from giant honey bees in the study area through chemical and pollen analyses and how institutions influence the management of the giant honey bees (objective b). In chapter 4, a transdisciplinary method was used to map the presence of giant honey bees in the research area corresponding to a local scale (objective b). This follows Kueffer et al. (2007), who recommended that projects should publish methodological insights gained through an interdisciplinary research process.

Chapter 5 and 6 lay down perspectives leading to target knowledge. In chapter 5, further analysis was done on the baseline map created in chapter 4 alongside quantitative and qualitative analyses on field data gathered through community surveys, focus group discussions, and key informant interviews to analyze the linkages between the giant honey bees and the indigenous honey hunters (objective d). Chapter 6 uses a gross margin and integrated value chain analysis incorporating socio-cultural analysis to analyze the livelihood implications of commercializing a forest product traditionally hunted for subsistence purposes (objective e).

Chapter 7 provides transformative knowledge by making recommendations to adapt current global standards to the diversity of honey bees and, in the process, correct failures in the honey market to pave the way towards improved protection of honey bee species, preservation of their habitats, and improved livelihood of indigenous communities dependent on wild honey.

Chapter 8 concludes the dissertation with a synthesis of results, highlighting important findings. Chapter 9 provides an outlook for future research and development of praxis.

1.4 Information on the study area, community, and species

1.4.1 Palawan island

Historically populated by purely indigenous peoples, Palawan island in the Philippines is the country's "last frontier," where primary forests and high levels of biodiversity still remain (Austin and Eder 2007; Butler 2014). As an example, 54% of native non-flying contemporary mammal species are endemic to Palawan (Esselstyn et al. 2004). Because of this, it has been declared as one of three United Nations Educational, Scientific and Cultural Organization (UNESCO) Man and Biosphere Reserves in the Philippines. Palawan is located on the north-eastern margins of the Sunda Shelf ocean platform, which also includes Peninsular Malaysia, Java, Sumatra, Bali, and Borneo, and is surrounded by the South China Sea to the north and the Sulu Sea to the south. (Mollengraaff 1921; Piper et al. 2011). Its present-day environment is broadly similar to that of north Borneo, comprising lowland tropical rainforest ($\leq$ 1200 meters), which grade into submontane and eventually montane forest ($\geq$ 1600 meters). Sundaland, like the whole of the Philippines, is a leading biodiversity hotspot in terms of endemics (Myers et al. 2000).

An impending biodiversity disaster, as predicted by Sodhi et al. (2004), will not only affect flora and fauna but also the indigenous peoples of Palawan. Three indigenous groups, namely the Bataks, Pala'wans, and Tagbanuas, live on Palawan island but they have since been pushed further upland due to migrant influx to this resource-rich island (Novellino 2000). Because of this, conservation efforts focus on engaging indigenous communities as primary stewards of the remaining forests in the highlands. A regional non-government organization (NGO) called Non-Timber Forest Products Exchange Programme (NTFP-EP) Asia supports a network of indigenous peoples all over South and Southeast Asia in creating CFEs as ICDPs. In Palawan, there are nine indigenous peoples organization being supported by NTFP-EP Philippines. One of these is the *Samahang Katutubong Tagbanua ng Sagpangan* (SAKTAS) translated as Association of Indigenous Tagbanua of Sagpangan in the municipality of Aborlan in Palawan (see Figure 1.5; note that no GPS coordinates are published in any part of this dissertation to protect the privacy of the community).

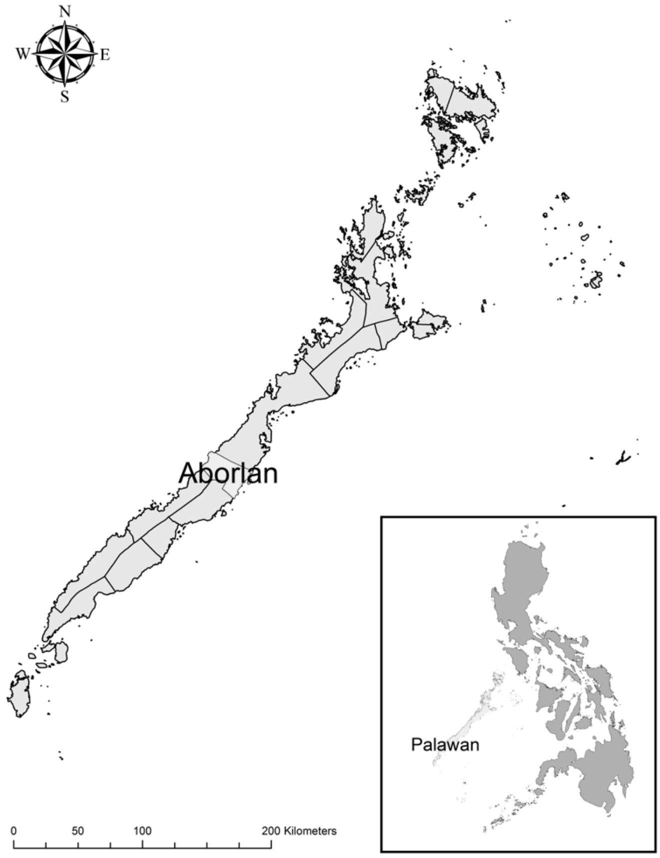

Figure 1.5 Map of Aborlan. Aborlan is located on the island of Palawan in the Philippines.

1.4.2 The indigenous Tagbanua community of Sagpangan, Aborlan in Palawan

With a population of approximately 1,500 individuals, the Tagbanuas in Sagpangan are shifting cultivators and gatherers of forest products such as honey, beeswax, rattan *Calamus* spp. (Arecaceae), and tree resin from almaciga *Agathis philippinensis* Warb. (Araucariaceae) in their community forest of 2,000 hectares (Fox 1982; Connelly 1985; PSA 2016). NTFP-EP Philippines, along with the local Palawan NGO *Nagkakaisang mga Tribu ng Palawan* (NATRIPAL) translated as United Tribes of Palawan, developed a CFE out of the traditional indigenous practice of wild honey hunting and gathering from wild honey bees especially from giant honey bees and, to a limited extent, the Eastern honey bee (*A. cerana* Fab.). The wild honey CFE is similar to the case of professional honey gatherers in Borneo, where honey gathering generates significant income despite being a seasonal opportunity (Koeniger et al. 2010). As the community contributing the largest amount of honey gathered in their community forest, Sagpangan is seen as an appropriate case study for wild honey CFEs. The large amount of honey gathered may be attributed to increased human, natural, and economic capital, which correspond to the objectives of this dissertation.

The honey gathering process begins with a massive search for beehives in the community forest. As in Borneo, honey gathering mainly takes place in areas with rainforests or little-disturbed vegetation (Koeniger et al. 2010). Honey hunter-gatherers travel to the forest in groups of three or four people and eventually disperse in the deep forest to individually look for beehives. They usually stay in the forest for around three to four days or, in some cases, up to one week. The search for beehives can take half-a-day and the rest of the day can be dedicated to gathering the honeycombs. Honey gatherers traditionally climb tall nesting trees in the community forest without rope protection or makeshift ladders. This is unlike the gathering system of Borneans who use movable ladders made from bamboo or rattan or drive bamboo pegs into trees to create stairways (Lahjie and Seibert 1990; Koeniger et al. 2010). They climb the tree with a lit coconut husk as a smoke torch to temporarily ward off bees from the beehive, an *itak* (bolo knife) to slice the honeycomb, and a container for the harvested honey. Often they only gather honeycombs that are ripe enough for gathering, i.e., honeycombs with mostly capped cells. Traditionally, they engage in entomophagy, eating the brood (often the larvae) of the bees along with a little amount of honey. Beeswax has also been traditionally important in rituals (Fox 1982). The indigenous Tagbanuas have a long history with the giant honey bees and its habitat. More information about this are provided in Chapter 5.

1.4.3 The wild honey community forestry enterprise

The Tagbanua people of Sagpangan are only involved in the gathering and consolidation of wild honey during the flowering season from March until July or August. There is no guarantee that wild honey can be gathered every year, especially if the floral resources do not produce flowers or if the summer temperatures are too hot, which dry up the nectar of the flowers.

In 2016, there were 79 wild honey hunter-gatherers from Sagpangan (seven of whom are females) and five consolidators. The transition to wild honey CFE instituted changes to the gathering practice as part of a standardization process instituted by NTFP-EP Philippines such as lining the container with unused plastic cellophane and leaving the brood intact upon gathering. The hunter-gatherers sell the gathered honey to the consolidators, who weigh the honeycombs and label these with the names of the sellers. Earnings from the honeycombs gathered are equally divided among the hunter-gatherers.

The consolidators may only store honeycombs for up to five days to avoid fermentation. They should then transport the honeycombs to NATRIPAL based in Puerto Princesa, which is 85 kilometers north of Sagpangan. NATRIPAL only accepts intact honeycombs because squeezed honey may contain foreign particles such as pollen or brood, which may shorten the shelf life of the honey. Most of the costs of consolidators are connected with renting transport for the honeycombs since no public transport to Puerto Princesa is available in the community. SAKTAS receives one percent of the proceeds from all the honey sold by consolidators to NATRIPAL.

Upon reaching NATRIPAL, the honeycombs are processed into honey and beeswax. The honeycombs are filtered for its honey and are later on cooked for beeswax. The filtered honey is either bottled under sterile conditions for sale in NATRIPAL's shop or is shipped in big containers to retailers. Retailers bottle the honey under their own label and sell it to other businesses or individual customers. The beeswaxes are sold in blocks to retailers or individual customers. In chapter 6, more information is provided about the operation of the wild honey CFE. It also discusses the socio-cultural and economic sustainability of transforming the traditional practice of wild honey gathering to a commercial enterprise.

1.4.4 The giant honey bees

Belonging to the order Hymenoptera and the family Apidae, the giant honey bee (*A. dorsata*) was discovered by the Danish zoologist Johan Christian Fabricius in 1793. It is one of nine honey bee species belonging the genus *Apis* and is an open-nesting species that cannot be domesticated in Langstroth boxes like the European honey bee. It can be found in South and Southeast Asia, with large open nests reaching 1.5 meters wide nesting on the underside of branches of tall trees, cliff faces or, in some cases, on ceilings of buildings (Seeley 1985; Crane 1999). Swarms of giant honey bees migrate between two or three areas during the year and regularly occupy the same nest sites in each area even after seasonal migration (Crane 1999; Neumann et al. 2000). How the giant honey bees do this is unknown, as honey bee workers live for only a few weeks (Paar et al. 2000). This specific characteristic of giant honey bees is advantageous to hunter-gatherers since they only need to remember the nesting sites from the previous season and return to these sites for the next hunting season.

Giant honey bees often nest exposed in aggregations and in very tall trees, but this is not the case with giant honey bees from the Philippines, where only giant honey bees nest individually per tree (Starr et al 1987). Two subspecies of giant honey bees can be found in the Philippines: the giant honey bees in Palawan are from the subspecies *A. dorsata dorsata*, which is similar to those in Borneo, while the giant honey bees in the rest of the Philippines are from the subspecies *A. dorsata breviligula* (Starr et al. 1987; Koeniger et al. 2010). Despite these differences, one giant honey bee hive can provide equal, if not larger, amount of honey than one hive of European honey bee can produce in one season (Rinderer et al. 1985). These provisioning ecosystem services and more are discussed on a global perspective in the next chapter. On a local scale, specific information about the nectar sources of giant honey bees in Palawan and other characteristics of their honey can be found in chapter 3. We return to a global level on Chapter 7, where information on the academic and market awareness of the diversity of honey bees can be found.

Figure 1.6 The nine honey bee species. These are worker bees of the nine species belonging to the genus *Apis* (Source: Koeniger et al. 2010).

2 Assessment of ecosystem services from wild honey bees across social contexts

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2.1 Abstract

In order to understand the role of wild bees in both social and ecological systems, we conducted a quantitative and qualitative review of publications dealing with wild bees and the benefits they provide in social contexts. We classified publications according to several attributes such as services and benefits derived from wild bees, types of bee-human interactions, recipients of direct benefits, social contexts where wild bees are found, and sources of changes to the bee-human system. We found that most of the services and benefits from wild bees are related to food, medicine, and pollination. We also found that wild bees directly provide benefits to communities to a greater extent than individuals. In the social contexts where they are found, wild bees occupy a central role. Several drivers of change affect bee-human systems, ranging from environmental to political drivers. These are the areas where we recommend making interventions for social-ecological conservation.

2.2 Introduction

Worldwide, wild bees along with managed honeybees are the main and most economically important group of pollinators (Kremen et al. 2007). Among other biotic pollinating agents, bees are the most effective because of their high flower reliability and flower constancy (Roubik 1995; Garibaldi et al. 2013; Rader et al. 2016). This means that bees actively seek out flowers and are able to identify even in diverse settings the exact species they prefer to visit. Reported declines in bees have raised an alarm over their conservation (Biesmeijer et al. 2006; Goulson et al. 2008; Potts et al. 2010). The decline seems to be multi-causal and driven by human activities such as deforestation and land use change, pesticide use in agricultural lands, pathogens and parasites, bee keeping practices, and – more recently – climatic change (Roubik 1995; Le Conte and Navajas 2008; Oldroyd and Nanork 2009; González-Varo et al. 2013). Initially the focus has been primarily on managed honeybees as they were regarded as the economically more important pollinators (Southwick and Southwick 1992; Morse and Calderone 2000; Allsopp et al. 2008 as quoted in Jaffé et al. 2009; Garibaldi et al. 2013). Feral and wild bees, however, are important because they are reservoirs of local adaptations, which are said to ultimately determine the survival of honeybees in the wild (Matheson et al. 1996 as quoted in Jaffé et al. 2009). Despite the impact of human activities on wild bee decline, the majority of research is comprised of ecological studies (e.g. Patiny et al. 2009; Winfree 2010). Human-insect connections garner relatively little attention and a comprehensive review on wild bees interaction with humans is yet to be conducted (Watson and Stallins 2016).

In this review chapter, we aimed to understand how research is framing the role that wild bees play in social-ecological systems. Social-ecological systems (SES) are linked natural and social systems. The involvement of people in biophysical structures or processes demonstrates how SES are formed. Because of the extent of environmental impacts caused by anthropogenic activities, it is disadvantageous to ignore social systems when studying the functioning of the natural environment (Bodin and Tengö 2012). Hence an in-depth understanding of both social and natural systems is pivotal for improving stewardship of natural resources and ecosystem services for human wellbeing and sustainability (Boyd and Folke 2012). One way of doing so is to link social and ecological components in a common framework of a systems approach (Westley et al. 2002). A systems approach allows for scrutiny of the way in which humans and nature, i.e. in our context wild bees, interact and the impacts that they have on each other. This would provide information on the different types of environment where wild bees occur as well as the influence humans have on them and their habitat.

We conducted a mixed quantitative and qualitative literature review targeting publications that explicitly deal with bee-human systems. It is important to establish the current state of knowledge on wild bees in social contexts in order to identify gaps and leverage points where intervention for conservation is possible and promising and to highlight key gaps in our understanding that should be addressed by future research.

In order to examine the way in which the social dimensions of wild bees are being researched, we have four objectives in this chapter. Objective one (1) is to identify trends in research around wild bees and human interactions; objective two (2) is to examine the frameworks being used to understand wild bee and human interactions; objective three (3) seeks to characterize the interactions between humans and wild bees; and objective four (4) identifies drivers of change in wild bee and human interactions.

Our review draws on literature that make elements of a SES explicit. We examined the direct benefits that wild bees provide to people, which the 2005 Millennium Ecosystem Assessment (MEA) defines as ecosystem services. Ecosystem services are derived from biophysical structures or processes through several steps of transformation in a cascade (Haines-Young and Potschin 2010). By attributing value to a biophysical structure or process, people become involved in the transformation of biophysical structures or processes to ecosystem services (Spangenberg 2014). As these services are co-produced by both humans and nature, it therefore has an intrinsically social-ecological character (Andersson et al. 2007; Reyers et al. 2013; Queiroz et al. 2015). The ecosystem cascade framework of Haines-Young and Potschin (2010) is useful in analyzing the ecosystem services wild bees mediate. In the ecosystem cascade framework, a function of a landscape structure or process cannot be regarded as a service unless people consider the function as a benefit (Haines-Young and Potschin 2010). The ecosystem cascade framework highlights that services go hand-in-hand with the needs of the people (Haines-Young and Potschin 2010).

We also consider the role of wild bees in livelihoods, particularly as defined by the sustainable livelihoods framework of Scoones (1998). The sustainable livelihoods framework looks at the combination of livelihood resources (natural, economic, financial, human, or social capital) that result in certain livelihood strategies, given particular contexts and institutional processes. Sustainable livelihoods outcomes, such as poverty reduction or improvement of wellbeing and capabilities, are the envisaged endpoints of the framework (Scoones 1998).

In the following methodology, we outline our approach for identifying and analyzing literature. We further present our quantitative and qualitative approaches to answering our four research objectives. The results section addresses each objective in turn. In the discussion section, we argue that our results indicate that there is increasing recognition of the interlinked nature of wild bees and humans. We conclude this review by highlighting challenges in researching bee-human systems and providing recommendations for further development of the field.

2.3 Methodology

Following the review framework of Newig and Fritsch (2009), we conducted a thorough search of full articles through Scopus using search terms that exclude managed honeybees and studies of bees with no human interaction. This included articles published as early as 1916 until July 2015. The search string that was used can be found in Appendix I.

The resulting number of bibliographies was 8368. We narrowed down this number by further excluding journal articles from the basic research fields, which do not investigate interactions with humans. These are the fields of astronomy, biochemistry, chemistry, engineering, genetics, molecular biology, and physics. We then reviewed the abstracts of the remaining journal articles and thereafter selected publications that contain information on wild bees and humans, leaving 71 publications that were then studied in detail. A further assessment was conducted using close reading of the articles. Only articles written in English showing wild bee-human interaction were considered, resulting to a final count of 46 publications (listed in Appendix I) for review and coding. Most of the excluded articles treated wild bees and humans as separate entities.

Each publication was reviewed and coded based on several criteria (Table 2.1). In order to understand trends in wild bee research (objective one), we identified basic information about each paper. This included year of publication, disciplinary focus, country of origin of first authors and co-authors, and country of study. We performed descriptive statistics on each of these metrics, and generated tables and figures through R software version 3.0.2 and its packages bipartite, ggplot2, and sjPlot. Additionally, we performed inferential statistics using Stata 14.0 and MATLAB R2016b on the number of publications per year and the association of wild bee services and benefits with either the livelihood or ecosystem frameworks. For objective two (the frameworks for understanding interactions), we distinguished whether the research was examining human and wild bee interactions through the livelihoods framework (Scoones 1998) or the ecosystem cascade framework (Haines-Young and Potschin 2010). If no information was available the answer provided was N/A or not applicable. Descriptive statistics as well as figures and tables were generated as in objective one.

In order to characterize the interactions between humans and wild bees (objective three), we focused on both the way in which humans benefitted from wild bees, and the way in which human activities impacted upon the bees. Therefore, each publication was analyzed based on its scale of study, wild bee-human interaction and its corresponding services or benefits, its use of livelihood, the social context where bees are found, and the direct gainer of benefits from the wild bees. Drivers of change to wild bee-human interaction were also identified from each publication (objective four).

Table 2.1. Criteria for review of publications

Journal information	Information on bees	Methodological information	Analytical information
Year of publication	Genus or species of bees	Methods of identifying benefits	Role of bees in social context
Type of paper (e.g. case study, review, etc.)	Type of bee habitat	Methods of quantifying benefits	Place in the ecosystem cascade framework
Discipline	Type of human interaction or activity	Framework used	Place in the livelihoods framework
Thematic focus	Services identified		Gainer of direct benefit
Country of institution of first author	Benefits identified		Drivers of change
Country of study			
Scale of the study			

2.4 Results

2.4.1 Trends in wild bee – human interaction research

The number of publications dealing with wild bees in social contexts increased between 1982 and 2015 (Figure 2.1). We see from the figure that there were deviations in some years but, in general, there were more publications that dealt with both wild bees and humans during the last decade as compared with the previous years.

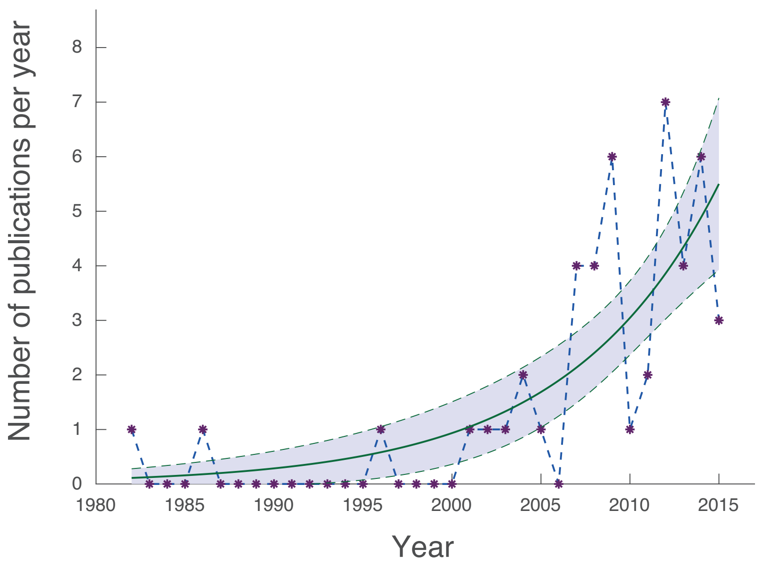

Figure 2.1 Increase in publications. There is a general trend of increase in publications on wild bees in social contexts during the last decade. The shaded area is the 95% confidence region of the nonlinear regression.

We conducted a Mann-Kendall test to determine the statistical significance ($\alpha = 0.05$) of the increasing number of publications per year. The tests resulted to a Kendall's tau-b of 0.589 with significance probability (p) = 0.000 (rounded to three significant digits) indicating that there is a strong positive correlation between the year of publication and the number of publications (Table 2.2). To corroborate this result, we also ran a Spearman's rank correlation, which resulted to a Spearman's rho of 0.732 with p = 0.000 (rounded to three significant digits) (Table 2.3).

Table 2.2. Mann-Kendall test results

Number of obs =	17
Kendall's tau-a =	0.5074
Kendall's tau-b =	0.5830
Kendall's score =	69
SE of score =	22.767 (corrected for ties)
Test of Ho: Year and Publications are independent	
Prob > |z| =	0.0028 (continuity corrected)

Table 2.3. Spearman's test results

Number of obs =	17
Spearman's rho =	0.7354
Test of Ho: Year and Publications are independent	
Prob > |t| =	0.0008

These results show that there is a clear monotonic increase in publications throughout the years, but the relevant question at this point is whether this increase is compatible with an exponential law. Through a nonlinear regression test, we see that the doubling time for the amount of publications is 5.9 years with a confidence interval (95%) of 3.3 - 8.4 years. If this trend is sustained, thereby confirming the exponential law, this means that we are now witnessing the onset of a rapidly increasing field.

Most of the publications reviewed had their research conducted in Africa, Asia, and Latin America. Authors based in Europe conducted research only in these regions; conversely, authors from Asia, Africa, Latin America and the Middle East conducted studies only in their own region (Figure 2.2). Authors based in North America conducted research in all other regions except Australia and the Middle East. Two publications had first authors with dual affiliations: one with Asia and Europe and another with Africa and Asia. These show that one-third of the publications had its research conducted in countries outside of the first author's region. In addition, the majority of these publications had co-authors from the country where the research was conducted. When these publications were grouped according to discipline, the majority of the publications came from the fields of ecology followed by anthropology (Figure 2.3).

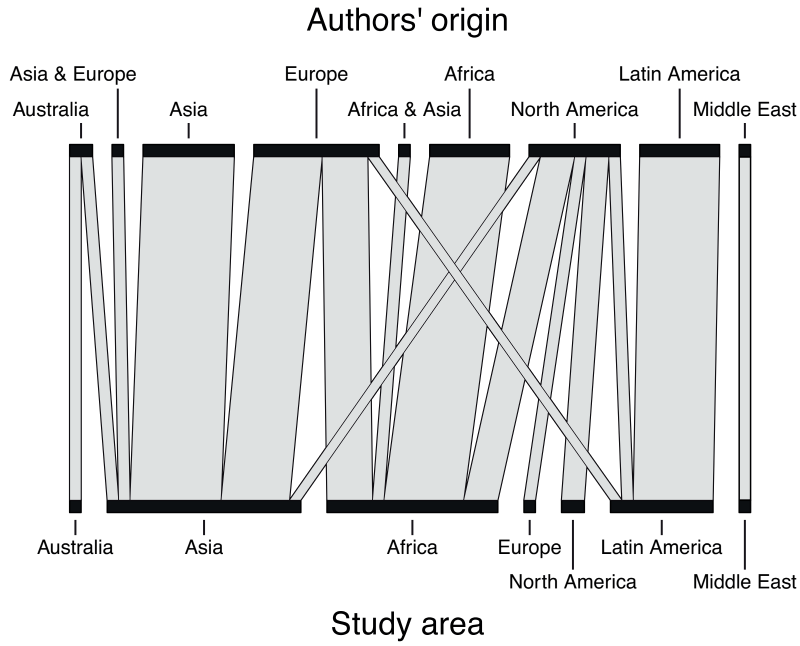

Figure 2.2 Research mobility in the Northern Hemisphere. Most of the (first) authors from the Northern Hemisphere conducted their studies outside of their own region. European first authors conducted research in Asia, Africa, and Latin America while North American first authors conducted research in all regions except Australia and the Middle East. First authors from Africa (with the exception of one author with dual affiliation with Asia), Asia, Latin America, and the Middle East conducted research only in their own regions.

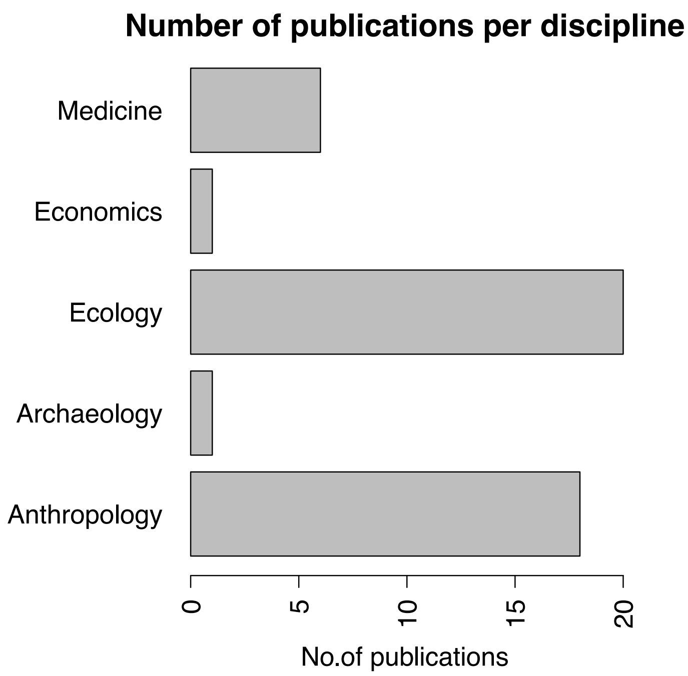

Figure 2.3 Domination of ecology and anthropology. Most of the publications on wild bees fall within the fields of ecology, followed by anthropology.

There were also several medical publications and one each from the fields of economics and archaeology. Most of the benefits were identified through qualitative methodologies such as interviews, participant observation, focus group discussions, or literature review. Quantitative methodologies such as economic valuation or retrospective panel approach were also used to a limited extent. Where quantitative methodologies were used, benefits were quantified through volume or monetary value of hive products. The majority of the publications were focused on a community scale, with several publications also working on a provincial scale. Most of the studies found wild bees in forested areas, while some studies also found wild bees in agricultural land and urban areas.

2.4.2 Frameworks for understanding wild bee – human interactions

The livelihoods framework has been the most popular framework for understanding human interactions with wild bees. The majority (57%) of the publications reviewed used the livelihoods framework while a minority (39%) used an ecosystem cascade framework. Two of the publications did not use any framework. Despite only a small number of publications using an ecosystem cascade framework, the framework has been increasingly used in the more recent years. In fact, all of the reviewed publications in 2015 used the ecosystem cascade framework.

The livelihoods framework publications mostly focused on services and benefits from wild bees as both natural and economic capital. Most of the livelihoods framework publications identified wild bees and their products such as beeswax, cerumen, honey, propolis, and royal jelly as services, which provide material benefits that can be sold in order to obtain cash income. All publications, except for two, using the livelihoods framework were case studies. Almost all (93%) of the countries of study were located in developing countries in Africa, Latin America, and Asia, except two publications that conducted studies in Australia and the Mediterranean region.

The ecosystem cascade framework publications, on the other hand, mostly dealt with service (flows) in the cascade. Wild bees and their products were the services that provided benefits in the form of food, medicine, pollination, and religious and social life. Majority (67%) of the studies were conducted in Asia and Latin America while studies conducted in the Middle East, Africa, and North America were only a minority (33%). Most of the countries of study (67%) using the ecosystem cascade framework also belong to the Group of Twenty (G-20) major economies.

We conducted Fisher's exact tests to see whether there was a statistically significant relationship between services or benefits and the analytical frameworks. The Fisher's exact test for services resulted to $p = 0.067$ (Table 2.4), while for benefits it resulted to $p = 0.000$ (rounded to three significant digits) (Table 2.5). The results show a statistically significant relationship at $\alpha = 0.10$ between the frameworks used and the services from wild bees, but not at $\alpha = 0.05$ which is the case for the benefits.

We also conducted a χ^2 test to supplement the Fisher's exact tests and results for services from wild bees returned $\chi^2 = 6.85$ with three degrees of freedom and $p = 0.077$. The resulting contingency tables show that bees, pollen, and products were the services that contributed greatly to the χ^2 (Table 2.4). For benefits from wild bees, $\chi^2 = 19.8$ with four degrees of freedom and $p = 0.001$ (Table 2.5). Material, medicine, and food were the biggest contributors to the χ^2, which rendered the relationship with the analytical frameworks highly significant.

Table 2.4. Results of Pearson χ^2 and Fischer's exact tests for services from wild honey bees

Framework	Key	Honey	Pollen	Bees	Products	Total
Ecosystem services	frequency	13	2	5	3	23
	expected frequency	13.0	1.1	2.7	6.1	23.0
	chi^2 contribution	0.0	0.6	2.0	1.6	4.2
	row percentage	56.52	8.70	21.74	13.04	100.00
Livelihoods	frequency	21	1	2	13	37
	expected frequency	21.0	Eco 1.9	4.3	9.9.	37.0
	chi^2 contribution	0.0	0.4	1.2	1.0	2.6
	row percentage	56.76	2.70	5.41	35.14	100.00
Total	frequency	34	3	7	16	60
	expected frequency	34.0	3.0	7.0	16.0	60
	chi^2 contribution	0.0	1.0	3.2	2.6	6.9
	row percentage	56.67	5.00	11.67	26.67	100.00
Pearson chi^2(3) = 6.8581 Pr = 0.077 Fisher's exact = 0.067						

Table 2.5. Results of Pearson χ^2 and Fischer's exact tests for benefits from wild honey bees

Framework	Key	Food	Medicine	Material	Pollination	Culture	Total
Ecosystem services	frequency	4	10	4	6	2	26
	expected frequency	4.0	5.8	11.7	3.1	1.3	26.0
	chi^2 contribution	0.0	3.0	5.0	2.6	0.3	10.9
	row percentage	15.38	38.46	15.38	23.08	7.69	100.00
Livelihoods	frequency	5	3	22	1	1	32
	expected frequency	5.0	7.2	14.3	3.9	1.7	32.0
	chi^2 contribution	0.0	2.4	4.1	2.1	0.3	8.9
	row percentage	15.63	9.38	68.75	3.13	3.13	100.00
Total	frequency	9	13	26	7	3	58
	expected frequency	9.0	13.0	26.0	7.0	3.0	58.0
	chi^2 contribution	0.0	5.4	9.1	4.7	0.6	19.8
	row percentage	15.52	22.41	44.83	12.07	5.17	100.00
Pearson chi^2(4) = 19.8383 Pr = 0.001 Fisher's exact = 0.000							

2.4.3 Characteristics of interactions between humans and wild bees

All in all, services derived from wild bees were identified as the wild bees themselves, beeswax, cerumen, honey, pollen, propolis, and royal jelly. These services provided benefits in the form of culture (religious and social life), food, material, medicine, and pollination. The livelihoods framework publications focused on honey and other bee products as services and these have provided people with food and material, which they can sell in order to have cash income (Figure 2.4 and Figure 2.5). Conversely, the ecosystem cascade framework publications focused on pollen and bees as services, with medicine, pollination, and culture as benefits (Figure 2.4 and Figure 2.5).

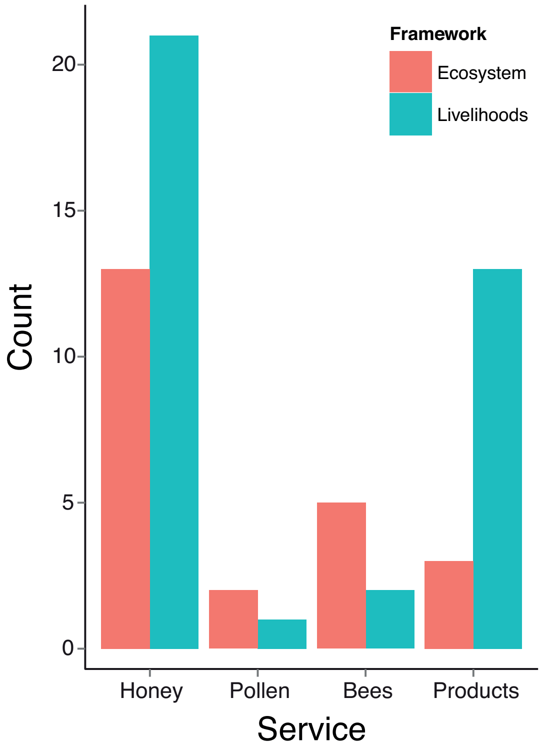

Figure 2.4 Comparison of wild bee services identified in publications that used either an ecosystem cascade or livelihoods framework

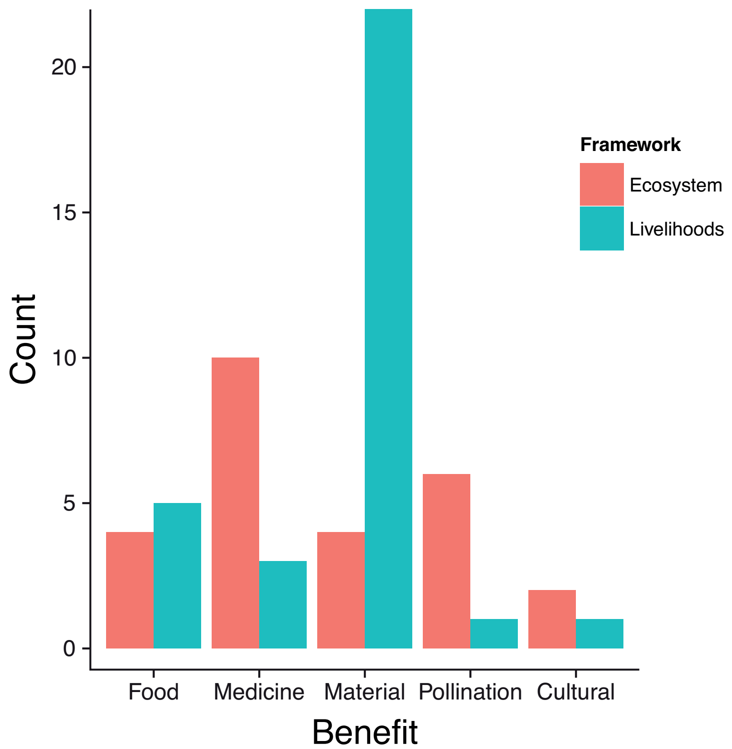

Figure 2.5 Comparison of benefits derived from wild bee services identified in publications that used either an ecosystem cascade or livelihoods framework

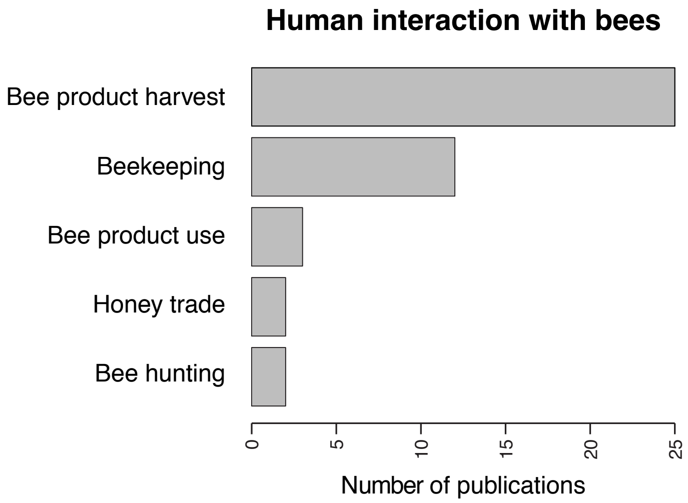

Figure 2.6 Wild bees in social contexts. Humans interact directly with bees during bee product harvest, beekeeping, or bee hunting. Indirectly, bees become involved in social contexts when their products are used or traded.

The majority of the publications also identified bees as central to the way of life of the people or communities involved in the studies. This assessment was based on the interaction of bees with humans. Human interaction with bees is mostly via bee product harvesting and beekeeping. Bee product harvesting mostly occurred in Africa (42%) and Asia (42%) and, to a certain extent, in Latin America (13%) and Australia (3%). Beekeeping was mostly identified in the studies conducted in Africa, Asia, and Latin America. In addition, two studies in the Mediterranean and the United States also focused on beekeeping. A few publications also identify bee product use, bee hunting, and honey trading as types of human interaction with bees (Figure 2.6). Bee product use and bee hunting were both identified in studies conducted in India and in Argentina and Brazil, respectively.

2.4.4 Sources of changes to the bee-human interaction

Drivers of change to wild bee-human interaction in the publications were also identified and these were mostly socio-cultural (36%) and environmental (32%) in nature. Governance systems (24%) also drive changes to wild bee-human interaction, while economic activities (8%) have minimal influence. These drivers of change have geographical trends. Most of the socio-cultural drivers are prevalent in developing countries in Africa and Latin America. The environmental drivers of change are predominantly found in developing countries in Africa and Asia. Governance systems drive changes solely in Asia-Pacific. Some of the drivers of change also have clear association with either the livelihoods or ecosystem cascade frameworks. The governance systems and economic drivers of change are all associated with the livelihoods framework. The socio-cultural and environmental drivers of change, on the other hand, are associated on equal terms with both livelihoods and ecosystem cascade frameworks.

2.5 Discussion

Our results show that research is framing the role of wild bees in SES as essential not only from an ecological point of view but also from a social point of view. Wild bees play a central role in social contexts in most regions of the world (Table 2.6). Whether it is through bee product harvesting or beekeeping or honey trading, humans greatly benefit from interacting with wild bees especially on the level of livelihoods. This interaction, however, drives changes in the wild bee-human system. Most of the changes are driven by socio-environmental causes, which are quite apparent in Africa and Asia. In the following subsections, we discuss our results in detail and suggest how an ecosystem services perspective can support efforts for wild bee conservation.

Table 2.6 Summary of results

Region	Dominant role of bees in social context 1 – Central 2 – Marginal	Dominant framework 1 – Livelihood 2 – Ecosystem cascade	Type of wild bee-human interaction 1 – Bee product harvesting 2 – Beekeeping 3 – Honey trading 4 – Bee hunting 5 – Bee product use	Dominant drivers of change 1 – Socio-environmental 2 – Socio-cultural 3 – Governance
Africa	1	1	1, 2, (3)	1, 2
Asia	1	1	1, 2, (4), (5)	1, 3
Australia	1	1	2	(3)
Europe	*	1	(2)	*
Latin America	1	2	1, 2, (4), (5)	2
Middle East	2	2	(3)	*
North America	*	2	(2)	(2)

() – minor extent; * – no data

2.5.1 Geographical trends of research involving wild bees and humans

Our results show that wild bee research in social contexts was mostly conducted in the regions of Africa, Asia, and Latin America. This is almost consistent with the biogeographic distribution of bees, with most taxa found in Latin America, followed by Africa and Asia (Michener 2007). For us, this trend also shows that direct interaction with wild bees is still prevalent in communities in Africa and Asia and, to a certain extent, in Latin America. It is, therefore, not surprising that most of the drivers of change to wild bee-human systems are mostly found in Africa, Asia, and Latin America. Some of our findings on the drivers of change have much in common with the synthesis by Brown and Paxton (2009), Potts et al. (2010) and González-Varo et al. (2013) of the factors affecting bees and animal pollinators, albeit differing on the level of importance. For example, Brown and Paxton (2009) and Potts et al. (2010) found that habitat loss, fragmentation, and degradation have a strong effect on bee or pollinator decline worldwide while in our findings, these only come second to socio-cultural drivers. A socio-ecological approach enabled us to see how socio-cultural processes drive ecological changes by taking into consideration biophysical interactions between societies and ecosystems (Gingrich et al. 2016).

All of the reviewed publications showed wild bees in a positive light, i.e., they bring services and benefits to humans. On the contrary, most of the changes to the wild bee-human systems were caused by human activities (Vanbergen and UK IPI

2013). High-quality habitats with increased plant diversity enhance wild bee communities not just in rural but also urban areas (Le Féon et al. 2010; Banaszak-Cibicka and Żmihorski 2012; Kennedy et al. 2013). If wild bee habitat loss continues to be induced by human activity, then an apparent imbalance between what wild bees provide and what humans give in return occurs.

2.5.2 Wild bees provide multiple ecosystem services

Analyzing the publications through the lens of the livelihoods and ecosystem cascade frameworks yielded a holistic picture of the interactions between humans and wild bees. Wild bees provide a broad spectrum of ecosystem services that range from provisioning to regulating to cultural. Provisioning ecosystem services were the focus of majority of the publications reviewed, especially those that used a livelihoods framework but regulating ecosystem services were also often cited, especially in publications that used the ecosystem cascade framework. This is consistent with the Millennium Ecosystem Assessment (MEA 2005) report showing a strong linkage between provisioning as well as regulating ecosystem services and human wellbeing in the form of health and basic material for good life as well as security. Cultural ecosystem services may only have a medium linkage to constituents of well-being in the MEA (2005) but they were also mentioned in some of the reviewed publications.

The livelihood and ecosystem cascade frameworks associate with different ecosystem services, but both are similar in addressing needs of people (Scoones 1998; Haines-Young and Potschin 2010). As our results show, the difference lies on the services and benefits identified in the ecosystem cascade framework publications not having mainstream market value, unlike those of the livelihoods framework publications. Cash income and employment play important roles in allowing ecosystem services to contribute to poverty alleviation, which is needed in the developing countries associated with the publications using the livelihoods framework (Daw et al. 2011). Despite identifying mostly nonmarket services, ecosystem cascade framework publications were conducted in countries belonging to the 20 major economies in the world. It is in the best interest of these G-20 countries to include nonmarket services in policy decisions in order for their societies to stay within the economically optimal point for human welfare; this would require incentivizing or investing in the provision of nonmarket ecosystem services (Fischer et al. 2008).

2.5.3 Beyond provisioning ecosystem services

Recognizing multiple ecosystem services from wild bees to humans may prove useful in engaging actors with different interests and goals to contribute to wild bee conservation efforts (Milcu et al. 2013). However, most of the reviewed publications only focused on provisioning ecosystem services of wild bees. In ecosystem management, if only one ecosystem service is focused on, considerable declines in the provision of other ecosystem services may occur (Bennett et al. 2009). One of the reviewed publications (de Carvalho et al. 2014) showed how a focus on provisioning ecosystem services led to the decline of cultural ecosystem services. Trade-offs often occur between provisioning ecosystem services and regulating or cultural ecosystem services (Meacham et al. 2016).

Trade-offs also occur between different ecosystem services and between the present and future supply of services especially when managing ecosystems for multiple ecosystem services and balancing the well being of different stakeholders (Carpenter et al. 2006; Daw et al. 2015). The example of Southeastern Nigeria previously mentioned showed how outright felling of trees could provide honey (Okoye and Agwu 2008). However, prioritizing this provisioning ecosystem service may lead to declines in biodiversity, water purification, and climate regulation if a forest is cleared (Carpenter et al. 2006).

There is much room for recognition of other ecosystem services such as cultural or regulating ecosystem services. Carpenter et al. (2006) point out that in trade-off decisions, people often prefer to prioritize provisioning ecosystem services over cultural and regulating ecosystem services. Daniel et al. (2012) highlight the importance of cultural ecosystem services and their potential to motivate and mobilize public support for the protection of ecosystems. Carpenter et al. (2006) mention that by paying attention to regulating ecosystem services, impact of extreme events can be moderated. For wild bees, increased attention to their cultural and regulating ecosystem services may further promote their conservation, especially with the reported declines over the past years (Biesmeijer et al. 2006; Cameron et al. 2011).

2.5.4 Wild bees in social contexts as a socio-ecological system

The drivers of change in wild bees-human systems show that resource management and sustainability problems are usually system problems where social and ecological systems are almost impossible to consider as separate entities (Berkes and Folke 2002; Rissman and Gillon 2017). While humans depend on bees for ecosystem services, the bees also depend on humans for survival since most of the drivers of change in wild bees-human systems are mediated by anthropogenic activities. This apparent interdependence between bees and humans show that the wild bees-human system is an SES, which is characterized by connectedness, context, and feedback (von Bertalanffy 1968 as quoted in Berkes et al. 2003; Keune et al. 2014).

In order to find ways of implementing sustainable practices, an understanding of what really drives the dynamics of societies in response to the ecosystems they depend on is needed (Scheffer et al. 2002). Most drivers of change caused by anthropogenic activities cause wild bees to be marginalized within the SES. Callo-Concha et al. (2014) discussed marginality (sic) in SES; however, it mostly focused on how social marginalization occurs due to ecological variables or ecosystem settings such as degraded soils inhibiting the wellbeing of people. We suggest that human-induced marginalization may also happen to ecosystems and its components. In this review, human-induced marginalization of wild bees is not just a product of overexploitation of wild bees and their hive products, but also of disregard for them and the conditions they thrive in. Marginalization of wild bees is, therefore, a product of human activity on the one hand and lack of human action on the other hand.

2.6 Conclusion

Our review establishes the current state of knowledge on wild bee-human interaction. We have chanced upon gaps in both research and praxis and we deem it important to address these. References to systems of governance (regulations or institutions) for wild bee-human systems are lacking in the publications we have reviewed. The International Pollinators Initiative (IPI), formally established in 2002 by the Convention of Biological Diversity, mostly focuses on bee interaction with agricultural landscapes and on one ecosystem service (regulating) in Africa, North America, and Oceania. Asia and Latin America, where most drivers of change also occur, should also be included in the IPI. Commitment is needed from governments and society to support the development of a stronger collaboration among researchers, policy makers, practitioners, and citizen stakeholders in order to advance sustainability (Fischer et al. 2015). In the field of research, our results show that wild bee publications in social contexts are still mostly confined within the fields of ecology or anthropology. Interdisciplinary and transdisciplinary approaches are still needed to make studies integrative and to promote co-production of knowledge with stakeholders. If studies are to help the wild bee-human system, the drivers of change especially in developing countries should be addressed in a manner that minimizes trade-offs between ecosystem services and maintains or improves wellbeing.

3 Ecosystem services and local management practices on giant honey bees in Palawan, Philippines

3.1 Abstract

The decline of managed honey bees has caused alarm all throughout the world due to the importance of its ecosystem service of pollination. However, the same amount of attention has yet to be extended to other honey bees such as the giant honey bee, which is extant in the forests of South and Southeast Asia. Often hunted by indigenous peoples, the giant honey bee is better known for its cultural and provisioning ecosystem services. In order to understand the role of these ecosystem services in local management practices, we conducted a pesticide residue and pollen analysis of honey from giant honey bees and spatial analysis of an indigenous community forest in Palawan, Philippines. We also characterized institutional knowledge on sustainable harvesting of wild honey through qualitative methods. The majority of the 251 households we interviewed use honey as food, medicine, and material. Only a small percentage of these households use pesticides and fertilizers, but all pesticides used are known to be harmful to bees. We find that current institutional norms and regulations are geared towards maintaining the provisioning ecosystem service of giant honey bees and tend to overlook other ecosystem services and functions in the landscape. We recommend using a landscape approach in order to capture the tradeoffs of favoring one ecosystem service over another and to consider both ecosystem services and functions in local management practices.

3.2 Introduction

Wild bees provide a wide range of ecosystem services from provisioning to regulating to cultural (Matias et al. 2017). The decline of bees, specifically the European honey bee, focused on the regulating ecosystem service (pollination) from bees as a main argument for conservation (Watanabe 1994; Potts et al. 2010). However, it has been argued that delivery of crop pollination service is insufficient in pushing for wild bee conservation since only a few species provide this service (Kleijn et al. 2015). Highlighting other ecosystem services can be helpful as it may engage actors with different interests and goals to contribute to conservation efforts (Milcu et al. 2013). In this chapter, we highlight the ecosystem services of a wild bee, the giant honey bee and identify their contribution to the conversation of conservation of wild bees. We focus on the provision of giant honey bees of hive products such as honey and beeswax, which has been sold commercially by an indigenous community for the past 20 years. In order to have a fuller picture of these ecosystem services and its role in local management practices facilitated by external institutions, we have three objectives in this chapter. Objective one (1) is to identify the characteristics of honey from giant honey bees relevant to conservation, i.e., pesticide residue and pollen content through laboratory analyses of honey samples; objective two (2) is to analyze land management practices and current use of honey by a traditional wild honey hunter-gather community; and objective three (3) is to characterize institutional knowledge on giant honey bees and sustainability of the commercial enterprise of honey.

This chapter draws on the three types of knowledge of knowledge presented by Brandt et al. (2013) in laying down the foundation for characterizing the social-ecological dynamics behind the generation of ecosystem services by giant honey bees within the community forest of indigenous Tagbanuas (Andersson et al. 2007). The three objectives correspond to system, target, and transformational knowledge, respectively. In the following methodology, we outline our approach in organizing the knowledge extracted from field-derived data. Subchapter 3.4 enumerates these three types of knowledge as they address each objective. In subchapter 3.5, we show how wild honey hunting and gathering by indigenous Tagbanuas is a linked SES, which has ecosystem services managed through different institutions. In our conclusion, we highlight the importance of using a landscape approach in managing the SES of giant honey bees in the community forest of indigenous Tagbanuas and we recommend further characterization of the giant honey bees' habitat as a starting point in operationalizing the landscape approach.

3.3 Methodology

Following the methodology employed by Andersson et al. (2007), we conducted our research in two phases: field-based data gathering and laboratory and desktop analysis. Data gathering was conducted in the UNESCO Man and Biosphere Reserve Palawan in the Philippines where three indigenous groups live. From 2014 to 2016, we visited and collaborated with indigenous Tagbanuas in the village of Sagpangan in the municipality of Aborlan. One of their traditional livelihood practices is hunting and gathering honey from giant honey bees (Venturello 1907; Fox 1982). Since the 1990s, they have commercially sold honey or whole honeycombs as part of a conservation and development initiative introduced by NGOs. The enterprise arm of the local NGO processes the honeycombs into honey and beeswax and sells the final products. Each product includes a label with information on the honey bee species from which the honey was gathered.

We sought to identify characteristics of honey from giant honey bees in Sagpangan village specifically its pesticide residue and pollen content (objective 1), which are both essential for ecological conservation and food safety. We collected twelve samples (60 mL) of honey from the honeycombs gathered by the wild honey hunter-gatherers in four locations and conducted pesticide residue and pollen analysis. We focused on locations where most giant honey bees are found by honey hunter and gatherers. Samples from other locations (Figure 3.1) would be helpful in establishing a database of potential nectar and/or pollen sources; however, this should be done in parallel with field monitoring of the foraging activity of giant honey bees given the limitations of pollen analysis (e.g. other pollen can be carried by wind to beehives or flowers visited by the honey bees) in establishing botanical origin of honeys for marketing purposes (Molan 1998). Nonetheless, pollen analysis can be a powerful tool in integrated conservation efforts by streamlining forest restoration or reforestation efforts while emphasizing the multiple ecosystem services provided by honey bees.

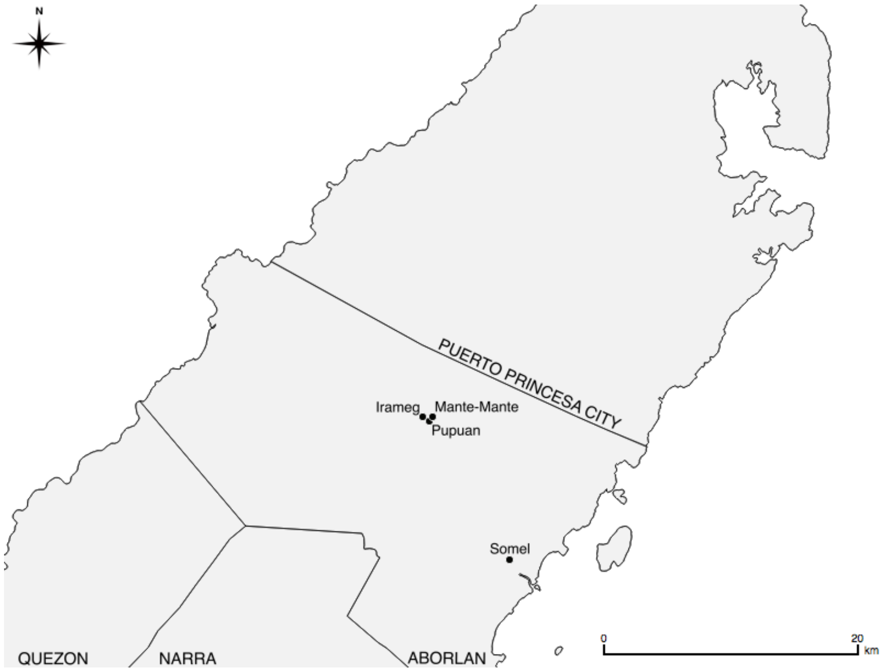

Figure 3.1. Four locations of honeycombs sampled for pollen and pesticide analyses. Honey samples were taken from Irameg, Mante-Mante, Pupuan, and Somel in Aborlan, Palawan.

Table 3.1. Limits of determination for pesticide residues and corresponding method of analyses. The honey samples were analyzed for the presence of 22 analytes derived from pesticides.

Analyte	Limit of determination (μg/kg)	Method
Bromopylates	3	SOP P-1-001 (z)
Coumaphos	3	SOP P-1-001 (z)
Fluvalinate	3	SOP P-1-001 (z)
Tetradifon	3	SOP P-1-001 (z)
Acrinathrin	3	SOP P-1-001 (z)
Chlorfenvinphos	3	SOP P-1-001 (z)
Thymol	50	SOP P-1-008
Dimoxystrobin	3	SOP P-1-001 (z)
Alpha-Cypermethrin	3	SOP P-1-001 (z)
Lambda-Cyhalothrin	3	SOP P-1-001 (z)
Iprodion	3	SOP P-1-001 (z)
Tolylfluanid	3	SOP P-1-001 (z)
Beta-Cyfluthrin	3	SOP P-1-001 (z)
Myclobutanil	3	SOP P-1-001 (z)
Deltamethrin	3	SOP P-1-001 (z)
Boscalid	3	SOP P-1-001 (z)
Kresoxime methyl	3	SOP P-1-001 (z)
Esfenvalerat	3	SOP P-1-001 (z)
Chlorpyrifos-methyl	3	SOP P-1-001 (z)
Azoxystrobin	3	SOP P-1-001 (z)
N, N-Diethyl-m-toluamide (DEET)	5	SOP P-1-005
Paradichlorobenzene	3	SOP P-1-008

Pesticide residue analysis of the honey samples was done by the Universität Hohenheim Landesanstalt für Bienenkunde in Germany using the maximum residue limits for honey established by the Codex Alimentarius Commission (FAO and WHO 2016) and the Residue Limit Ordinance of Germany (*Rückstands-Höchstsmengenverordnung* or RHmV version 21.10.1999) (Table 3.1). Pollen analysis was conducted at the IRD-Sorbonne Universités in France. Statistical analysis was run through Stata 14.2 and spatial analysis was done through QGIS 2.16.

To determine whether current community practices have a connection to the quality of honey, we gathered qualitative data on land management practice and bee product usage (objective 2) of 251 non-honey hunter households in the village of Sagpangan through interviews. Our interest lies on day-to-day practices that inadvertently impact giant honey bees; we excluded households of honey hunters and gatherers, whose actions may foremost be influenced by the marketability of honey. The respondents were asked about their household land holdings and the usage of pesticides or fertilizers in order to gauge land use practices. For bee product usage, the respondents were asked whether they eat brood or use honey, the amount they use (if any), and what they use it for. We coded the data through the typology used by Matias et al. (2017) and analyzed whether local use of honey closely follows the global scenario. To characterize the institutions facilitating local resource management, we assessed institutional knowledge on honey bees and sustainability of its enterprise (objective 3) through expert interviews with key persons in the local government, local community, and the supporting NGOs. In the interviews, we asked the key persons to identify the honey bees from an illustration showing the different honey bee species (Figure 1.6), the process of honey gathering, and their views on the sufficiency of current norms and regulations in ensuring sustainability of the commercial enterprise.

3.4 Results

3.4.1 Characteristics of honey from giant honey bees in Sagpangan

Results of the pesticide residue analysis showed that all honey samples do not contain any traces of chemicals listed on Table 3.1 (except DEET, which was not analyzed). Pollen analysis showed that the honey samples contain pollen from 11 plant families (see Table 3.2 and Figure 3.2). Most identification was only possible up to the family or genus level, with some species identified due to the presence of cytoplasm.

Table 3.2 Plant families, genus, or species results from pollen analysis. There are 11 plant families identified from the honey samples in total. Several genus or species were also identified, including *Rhizophora*, which belongs to the mangrove family.

Family	Genus or species
Arecaceae	e.g. *Cocos nucifera, Calamus*
Cunoniaceae	*Weinmannia racemosa*
Euphorbiaceae	e.g. *Manihot esculenta*
Fabaceae	*Erythrina variegata, Mimosa pudica*
Malvaceae	*Pterospermum obtusifolium*
Myrtaceae	e.g. *Eucalyptus, Decaspermum*
Rhizophoraceae	*Rhizophora*
Rubiaceae	*Psydrax odorata*
Rutaceae	*Acronychia*
Sapotaceae	*Mimusops elengi*
Sterculiaceae	*Acropogon*

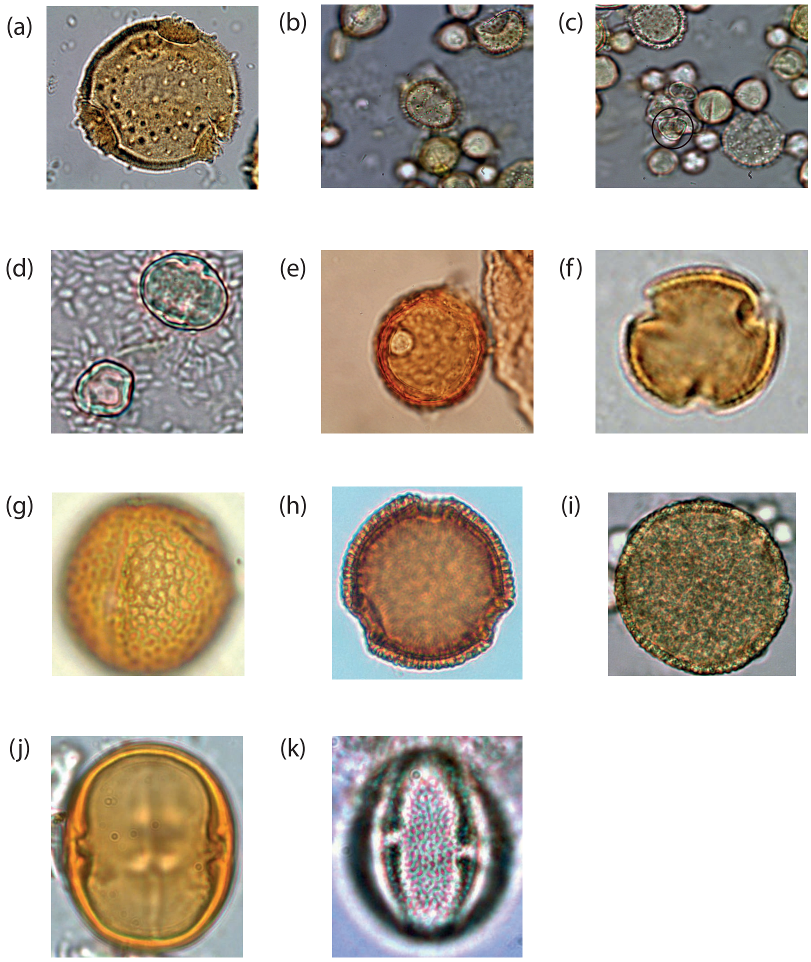

Figure 3.2 Results of pollen analysis. A total of 11 plant families were found in the honey samples from four locations in Sagpangan. These are (a) Malvaceae, (b) Arecaceae, (c) Myrtaceae, (d) Rhizophoraceae, (e) Fabaceae, (f) Cunoniaceae, (g) Sterculiaceae, (h) Rubiaceae, (i) Euphorbiaceae, (j) Sapotaceae, and (k) Rutaceae. Pollen sizes are not provided. (Courtesy of Anne-Marie Sémah, IRD-Sorbonne Universités France)

Table 3.3 Results of pollen analysis per sampling location. There was no significant correlation between NDVI and number of pollen families identified. This is expected since giant honey bees have long forage distances, which lead to honeycombs containing pollen from different areas.

	Irameg	Mante-mante	Pupuan	Somel
Pollen families identified	Arecaceae Cunoniaceae Fabaceae Malvaceae Myrtaceae Sapotaceae	Rubiaceae Sterculiaceae	Arecaceae Sterculiaceae	Cunoniaceae Euphorbiaceae Rhizophoraceae
NDVI	0.529	0.487	0.524	0.451
Pearson chi^2 (6) = 8.000 Pr = 0.238 Fisher's exact = 1.000				

The results of pollen analysis per sampling location can be found on Table 3.3. To see whether there was a correlation between number of pollen families identified and the vegetation cover, Pearson χ^2 and Fisher's exact tests were run. Results (p = 0.238) show that there is no correlation between the number of pollen families and vegetation cover. Further samples may confirm this relationship; however, since giant honey bees can forage great distances, pollen in the honey will reflect not only the flora situated within the immediate surroundings of their hives but also in farther locations.

3.4.2 Trends in local management

The majority of the respondents (67%) have land holdings, which are farmed on their own or rented out to the cooperative for palm oil cultivation. Respondents who rented out land for palm oil cultivation mention that the plants are treated with pesticide and/or fertilizer, but most are not aware of the details. All in all, only a small number of respondents use pesticide (4%) and fertilizers (20%). Of the 11 respondents using pesticides, only two use an organic pesticide and the rest use chemical-based pesticides (Table 3.4). The pesticides are classified as synthetic pyrethroids (Bushwhack, Cymbush, and Karate), carbamates (Furadan and Lannate) and organophosphate (Malathion). The respondents identified seven types of chemical fertilizers with different ratios of nitrogen, phosphorus, and potassium (N-P-K). Nine out of the 44 respondents using fertilizers use organic ones such as compost or animal manure (Table 3.4). The Philippine Statistics Authority (PSA 2017) release updates on fertilizer prices per month. The most expensive fertilizer is Complete (14-14-14), followed by Ammophos (16-20-0), Urea (45-0-0), and Ammosul (21-0-0).

Table 3.4 Pesticides and fertilizers identified by several respondents. There are more users of fertilizers than pesticides among respondents surveyed. Fertilizers are identified through their ratio of N-P-K (nitrogen – phosphorus – potassium). Note that several respondents identified fertilizers as pesticides.

Type of pesticide	Number of users	Type of fertilizer	Number of users
Cymbush	2	0-0-60	2
Bushwhack	2	14-14-14 (Complete)	18
Furadan	2	14-16-0	1
Karate	1	16-20-0 (Ammophos)	1
Lannate	1	50-50	1
Malathion	1	21-0-0 (Ammosul)	1
Organic	2	Organic	9
Total users of pesticides	11	45-0-0 (Urea)	12
		Algafer (Fertilizer)	3
		Crop Giant (Fertilizer)	1
		Total users of fertilizers	49

The majority of the respondents (94%) use honey. Of those using honey, 85% use this solely as food, 77% as medicine or vitamins, and 2% as material for selling or for feeding chickens. The majority of honey users (68%) have multiple uses for honey as both food and medicine. Only two of the respondents use honey as food, medicine, and material; one respondent uses honey as food and material; and one other respondent uses honey as medicine and material. The majority of the respondents (84%) have eaten brood (larvae) of giant honey bees. Only a few of the respondents (4%) know of any government regulation on harvesting of honey.

3.4.3 Local institutional knowledge on management of honey bees

Of the five authorities interviewed on their knowledge on giant honey bees, only the Indigenous Peoples Mandatory Representative (IPMR) could correctly identify the giant honey bee from the illustration. The IPMR is a government-mandated position representing the indigenous peoples in local councils. In the case of Sagpangan, the IPMR also happens to be an indigenous wild honey hunter and gatherer. All except for one of the interviewees, the village captain, have personally witnessed a wild honey gathering.

Regarding local regulations on harvesting of honey, all except the village captain are aware of several. The IPMR mentioned the regulations of the local office of the Deparment of Environment and Natural Resources (DENR), the local NGO representative mentioned the Philippine Forest Honey Network (PFHN)'s regulations, the network coordinator of indigenous honey enterprises mentioned the Bureau of Product Standards (BPS) of the Department of Trade and Industry (DTI), and the national NGO representative mentioned DENR, Department of Agriculture (DA), Food and Drug Administration of the Philippines (FDA) of the Department of Health. For international regulations, the local NGO mentioned the Participatory Guarantee Systems (PGS) of the International Federation of Organic Agriculture Movements (IFOAM), while the network coordinator and the national NGO representatives mentioned the Codex Alimentarius of the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) of the United Nations.

Most of the institutional representatives consider the existing regulations as enough to sustain the existence of wild honey bees. The IPMR mentioned that, as one of the community's honey hunters and gatherers, he follows the regulation set by the NGOs that only the honeycomb should be gathered and the rest of the hive, including the brood, should be left untouched on the tree. The local NGO as well as the network coordinator acknowledge this as part of a standard protocol ensuring sustainability of wild honey harvesting. Only the national NGO representative mentioned that the regulations are not enough for sustainability of wild honey bees. The representative said that regulations only focus on the honey through product standards, but there are no standards for the ecosystem. The representative also added that regulations must also look at the landscape and how these are being used. The local NGO representative, despite agreeing that the regulations are sufficient for sustainability, provided a similar recommendation on habitat preservation because the giant honey bees move further up the mountains and can no longer be found in the lowlands.

Table 3.5 Summary of responses of institutional representatives. Only the indigenous people mandatory representative could correctly identify the giant honey bee. The village captain answered no to all key questions. Non-government representatives have answered yes to most questions.

Legend ✓ Yes ✗ - No	Correct identification of giant honey bee	Witnessed honey gathering	Knowledge of local regulations	Knowledge of international regulations	Insight on sustainability
IPMR	✓	✓	✓	✗	✗
Village captain	✗	✗	✗	✗	(Unknown)
Local NGO	✗	✓	✓	✓	(✓)
Honey network	✗	✓	✓	✓	✗
National NGO	✗	✓	✓	✓	✓

3.5 Discussion

3.5.1 Wild honey records floral biodiversity

As one of the key species providing pollination, giant honey bees are known to have a maximum foraging range of 21 kilometers where they collect nectar and pollen; their pollen harvest paint a picture of the floral biodiversity present in their foraging habitats (Odoux et al. 2012; Seeley 1985). The pollen analysis identified 11 plant families, which are possibly pollinated by giant honey bees. This shows a mutually beneficial relationship of bees and floral resources: ensured pollination leads to improved regeneration of floral resources, while abundant nectar and pollen sources ensure survival of bee colonies (Svensson 1991). Pollen intake is important for worker bee survival and a laboratory study on the European honey bee by Di Pasquale et al. (2016) shows that slight reductions in pollen availability significantly reduced worker survival (Haydak 1970; Di Pasquale et al. 2013; Wang et al. 2014). The mutually beneficial relationship of bees and floral resources, therefore, shows the importance of protecting each of them in the interest of ecological balance. By providing a glimpse of the floral biodiversity existing within the community forest, pollen analysis can not only identify appropriate species to plant in restoration or reforestation efforts, but can also assist in cutting down costs of such initiatives by sourcing wildlings from the area instead of transporting seedlings from external sources, which also risks importing invasive species to the area.

Knowing the botanical and geographical origin of honey can help in the marketing of honey and increasing its commercial value (Estevinho et al. 2012); however, using pollen analysis to achieve this goal can only be helpful if there is already existing access to high-value markets. While mostly used for honey quality testing and improvement, pollen analysis also has great potential to assist in conservation planning. If there are limited resources for taxonomical field research of floral diversity, pollen analysis can be a scoping tool. The broad foraging range and migration ability of giant honey bees can capture floral diversity in a large area and record this in the honey that they produce. Coupled with spatial analysis, pollen analysis can also be a powerful tool in landscape management.

3.5.2 Giant honey bees provide ecosystem services to indigenous peoples

The traditional relationship of the giant honey bees and the Tagbanuas can be described as commensalism, where the Tagbanuas are the commensal and the giant honey bees are the host species. The Tagbanuas currently benefit from giant honey bees primarily through provisioning ecosystem services. Additionally, historical accounts show that giant honey bees also provide cultural ecosystem services (Venturello 1907; Fox 1982). The Tagbanuas used to perform a ceremony called *lambay*, portions of which are dedicated to invoking the appearance of bees. Apart from hunting honey and bee larvae, the Tagbanuas used beeswax for rituals (Fox 1982). The beeswax of giant honey bees has been shown as superior in terms of strength to beeswax of the European honey bee, the Eastern honey bee, and the black dwarf honey bee (*A. andreniformis* S.) (Buchwald et al. 2006; Buawangpong et al. 2014).

Similar to Matias et al.'s (2017) findings on the ecosystem services of wild bees in social contexts, honey is the primary service that Tagbanuas obtain from giant honey bees. The Tagbanuas primarily use honey as food and medicine and not primarily as material as found on the global level by Matias et al. (2017). The quality of the honey is of utmost concern since they are consumed by a group of people who have limited access to healthcare; for the Tagbanuas, healthcare is in the form of honey and other forest products. It is, therefore, of utmost importance that the wild honey from giant honey bees tested do not contain any traces of chemicals or pesticide residues. This shows that the honey from giant honey bees in Sagpangan has the potential to be classified as organic honey, since it is free of pesticides (Sereia et al. 2011). The presence of chemicals does not only cause bee mortality; it can also impair the quality and properties of honey and can put human health at risk (Rial-Otero et al. 2007; Bargańska et al. 2015).

The demand for organic food worldwide is increasing and is driving organic agriculture to be one of the fastest growing food sectors (Fromartz 2007; Seufert et al. 2017). While the organic characteristics of honey from giant honey bees is an opportunity to access higher-value markets, certification costs keep rural communities like the indigenous Tagbanuas from upgrading the value of their products. The constraints of organic certification, especially for smallholders, have long been known but entry barriers for third-party certification still exist (Home et al. 2017). IFOAM's PGS is an alternative, but it can only develop local markets, which – in the case of Palawan – cannot afford the higher prices of organic products (Home et al. 2017). Upgrading the status of wild honey to an organic product can contribute to the maintenance of ecosystem services and functions; however, the current system of organic certification seems to be more geared towards economic returns than environmental conservation.

3.5.3 The role of institutions in local management of giant honey bees

Judging from the responses of the institutional representatives (Table 3.5), the NGOs have more experience and knowledge on the issues on wild honey hunting and gathering of giant honey bees than the elected government official (village captain). The NGOs have significant roles in influencing the local management of giant honey bees despite being having no formal linkage to formal governance and management regimes (Pahl-Wostl 2009). The NGOs embody the characteristics of a bridging organization to varying degrees: they are a conduit for ideas and innovations, a source of information, a broker of resources, a negotiator of deals, and a conceptualizer of strategies (Brown 1991). However, among the three NGO representatives, it is the national NGO representative who seemed to have a systems perspective by being the only respondent to say that current norms and regulations in place are not enough for the sustainability of wild honey gathering. The national NGO representative highlighted the need to also conserve the landscape or habitat of giant honey bees, which the local NGO representative briefly mentioned. This is contrary to findings by Rist et al. (2016) that managers may have a greater focus on specific system components than broader ecosystem dynamics and services. However, the results show that current norms and regulations on wild honey harvesting are focused on maintaining the most popular ecosystem service (i.e., provisioning) and tend to overlook other ecosystem services. This reflects the evolution of ecosystem service thinking from an awareness-raising exercise to a foundation for market-like approaches to nature conservation and restoration (Huybrechs et al. 2014).

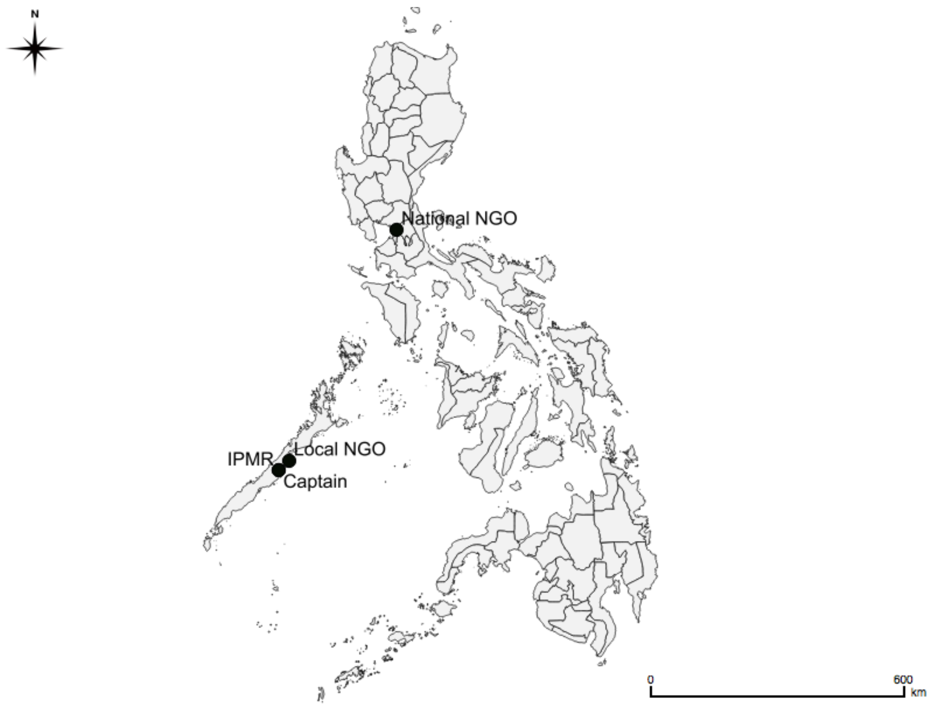

Figure 3.3 Location of institutions relevant to wild honey hunting and gathering in Sagpangan village. The national NGO is located outside of Palawan. The local NGO is based in the capital city of Puerto Princesa, which is 85 kilometers north of Sagpangan, where the IPMR and the village captain live.

A knowledge-action bottleneck also exists, wherein management knowledge is incubated at the national NGO level but rarely trickles down to the field level where all the management action is happening (Figure 3.3). Spatial fit, which is the matching of resource boundaries and the institutional regimes governing them, generally shows that spatial mismatches result to poor resource management (Young 2002; Herrfahrdt-Pähle 2014). In the case of wild honey hunting and gathering in the Tagbanua community forest, institutional effectiveness can benefit from a convergence of local, place-based experience with systems knowledge and perspective. The need to manage resources for multiple goals, for e.g. to maintain multiple ecosystem services as well as ecosystem functions, nowadays require not only training of local managers but a constant interaction between all actors in order to adapt knowledge to dynamic ecosystem changes (Rist et al. 2016).

3.5.4 Transformation towards sustainable natural resources management

Changing existing habits, practices, and institutional objectives require transformational knowledge (Brandt et al. 2013). Transformational knowledge is hinged on target knowledge, which are problem-solving measures derived from the natural constraints of the system and the interests of social actors, and on system knowledge, which shows the current state of the system (Jahn 2008; Brandt et al. 2013). The analysis of social-ecological systems includes these three types of knowledge, which is often used in transdisciplinary research. By sharing concepts and methodologies with complexity research and transdisciplinarity, social-ecological systems analysis is able to see the linkages between social and ecological systems and notice its dynamic changes (Campennì 2016). The pesticide residue and pollen analyses of honey from the giant honey bees provide a view of the system, where flora is diverse and hunter-gatherers have yet to harvest honey tainted with pesticide residues. However, we see that a certain percentage of the community still use chemical pesticides and fertilizers, which are harmful to bees. All of the pesticides (synthetic pyrethroids, organophosphates, and carbamates) mentioned by the respondents are known to be toxic to bees (Bernal et al. 2010; Maund et al. 2011; Lee et al. 2016). Fertilizers may also indirectly affect bees negatively. Nitrogen deposition, together with climate warming and carbon dioxide enrichment, affects flower morphology, phenology, flower sex ratios, and nectar chemistry (sugars and amino acids) (Hoover et al. 2012). Increased atmospheric nitrogen deposition can also reduce plant diversity (Bobbink et al. 2010). This not only alters the attractiveness of nectar to bees, but also reduces the longevity of worker bees (Hoover et al. 2012).

The IPMR, the local NGO, and the network coordinator see the harvesting protocol as sufficient for sustainability of giant honey bees; however, it is the national NGO representative's perspective of a landscape approach, which can inspire stakeholders to appreciate both ecosystem services and ecosystem functions and identify tradeoffs (Sayer et al. 2013). Ecosystem functions are natural phenomenon not directly utilized by humans and may be overlooked in favor of ecosystem services, which directly benefit humans (Hansen and Pauleit 2014; Spangenberg 2014). In order to transform to a more sustainable natural resource management in the area, both ecosystem function and ecosystem services should be taken into consideration.

3.6 Conclusion

Giant honey bees have long been providing cultural and provisioning ecosystem services to Tagbanuas in Palawan. Nowadays, giant honey bees are mostly exploited for their provisioning ecosystem service in the form of honey, which serve as food, medicine, and material to majority of the households in a Tagbanua community. Honey from the giant honey bees in the Tagbanua community forest in Sagpangan village in Aborlan has high quality, having zero traces of pesticide residues. Samples of honey from giant honey bees in the area contain pollen from at least 11 plant families, providing a snapshot of the floral biodiversity within the community forest and the flight range of the giant honey bees up to the mangrove areas. This can be helpful in tailoring future reforestation or land restoration efforts to use local native species. Despite only a minimal number of households using pesticides and fertilizers, all of the pesticides are known to be toxic to bees and the fertilizers can affect floral resources. Unfortunately, current institutional norms and regulations mostly focus on maintaining the provisioning ecosystem service of giant honey bees and overlook other ecosystem services from the giant honey bees' habitat. We recommend using a landscape approach with a focus on multifunctionality in order to identify tradeoffs from favoring the provisioning ecosystem service of giant honey bees over other ecosystem services. In order to operationalize this, we recommend further characterizing the giant honey bees' habitat through taxonomical surveys and GPS mapping in order to identify land uses and potential conservation areas. This can also assist in establishing a baseline for further research on maximum sustainable yield, which can assist in accurately setting a sustainable harvest amount of wild honey.

4 Mapping giant honey bee nests in Palawan, Philippines through a transdisciplinary approach

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4.1 Abstract

In a bid to understand the spatial distribution of giant honey bees in a community forest in Palawan, Philippines, participatory mapping was conducted with indigenous Tagbanua honey hunters and gatherers. Through the use of global positioning system devices, digital cameras, and a solar home system as electricity source, local collaborators mapped a total of 31 bee nests from April to June 2015. This study provides a replicable long-term participatory methodology and promotes participatory learning and mutual knowledge creation. By combining applied sustainability research with local stakeholder participation, we suggest that novel knowledge and solutions can aid sustainable rural development.

4.2 Introduction

Conserving forest areas populated by indigenous communities is not easily fulfilled through a protected area approach, which generally limits human presence and use of natural resources. Alternative approaches have, therefore, been sought to conserve forests while respecting human occupation by focusing on local use of forest resources except timber. Development organizations and multilateral agencies readily implemented the development of CFEs focusing on non-timber forest products, which seemed to address dual objectives of forest conservation and rural development (Sills et al. 2011). This strategy was employed in indigenous forest communities in South and Southeast Asia through a regional non-government organization called NTFP-EP Asia. In the UNESCO Man and Biosphere Reserve Palawan, known as the "last frontier" of the Philippines due to its high biodiversity (Austin and Eder 2007), the three indigenous groups (Bataks, Palawans, and Tagbanuas) living in different parts of the province have been involved in CFEs through the commercialization of their traditional subsistence practices. One such practice is wild honey hunting and gathering, which is also practiced in other parts of the Philippines. In Aborlan, one of the municipalities of Palawan, indigenous people of Tagbanua ethnicity traditionally collect honey from giant wild honey bees found in their community forest during the summer season (Venturello 1907; Fox 1982). Since the 1990s, Tagbanua honey hunters and gatherers have sold wild honey to external markets through the support of NGOs, such as NATRIPAL and NTFP-EP in the Philippines. However, there are several socio-economic and ecological challenges to the CFE. The quantity of wild honey fluctuates every year and there are harvesting seasons with very little, if at all, honey yield. This challenges the profitability of the CFE and the livelihoods of the Tagbanua hunters and gatherers. While reasons for these fluctuations are not yet known, the forest's spatial characteristics may give some hints since honey production depends on floral resources available in the forest while giant honey bee nesting depends on the availability of suitable trees (Seeley 1985; Koeniger et al. 2010). Looking at the forest cover and land use surrounding the community forest may reveal the status of floral resources and nesting trees of the wild honey bees, which would help in understanding the local forest resource use system (Landmann et al. 2015).

Most forest cover and land use analyses have been methodologically conducted through the integration of geographic information systems (GIS), socio-economic, and remote sensing techniques with landscape ecological approaches (Nagendra et al. 2004). In due course, GIS experts increasingly recognized the capability of local communities to share information and analyze their way of life and ecosystems, leading to a growing interest for participatory processes (Orban-Ferauge 2016). This provided the foundation for the current widespread use of participatory GIS, also known as PGIS, in research. The basic principle behind PGIS is the empowerment of communities through better integration of local demands, knowledge, and spatial analysis to support project decision-making (Rouse et al. 2007).

Using elements of both participatory learning and action and geographic information technologies, PGIS facilitates the representation of local people's spatial knowledge through the generation of two- or three-dimensional maps (Corbett et al. 2006). It has been used in several forest studies such as community carbon forestry planning in Cameroon (Minang and McCall 2006), management and conservation of a state forest in Brazilian Amazonia (Bernard et al. 2011), and in combining local landscape knowledge with land cover types to increase understanding of material use and cultural meaning of the Manaslu Conservation Area in Nepal (Shrestha and Medley 2016).

Building on the success of PGIS in interdisciplinary research projects, we used a transdisciplinary approach in baseline mapping of wild honey bee nests in the community forests around Sagpangan village, Aborlan municipality, Palawan province, through collaboration with indigenous Tagbanua wild honey hunters. We chose the Tagbanua community in Sagpangan for this study because they were identified by NATRIPAL as the community contributing the largest amount of gathered honey among all the CFEs in Palawan (personal communication, April 11, 2016). With a population of approximately 1500 individuals, the Tagbanuas in Sagpangan are shifting cultivators and gatherers of forest products such as honey, beeswax, rattan, and tree resin from almaciga (Fox 1982; Connelly 1985; PSA 2016).

This baseline mapping is part of an evaluation of the sustainability of the wild honey CFE as a social-ecological system. Given that the development intervention of NATRIPAL has been in place for more than two decades, we deem it important to assess its successes and challenges in rural development of indigenous forest communities. Our baseline mapping approach comprises longer-term involvement and development of local technical infrastructure and knowledge of indigenous Tagbanuas in Sagpangan. In the following sections, we outline the processes involved in designing and implementing mapping of wild honey bee nests in the community forests of Sagpangan and expound on the challenges and opportunities of using our approach in community forestry management contexts.

4.3 Methodology

Our baseline mapping approach required the transfer of knowledge, skills, and technology prior to implementation. We combined elements of participatory action research and traditional ethnographic research in order to design structures that can not only facilitate learning and empowerment in participating community members but can also support future contexts (Barab et al. 2004). Tagbanua honey hunters conducted the baseline mapping of giant wild honey bee nests during their wild honey gathering trips in their community forest. By integrating data collection in the routine of Tagbanua honey hunters, there was minimal disruption of usual tasks leading to efficient gathering of accurate results. Our baseline mapping approach comprised environment-centric and people-centric applications (Kanhere 2013). By marking the location of the bee nests through GPS units, we were able to get spatial environmental parameters of the giant honey bees, while taking photos of the surroundings provided documentation of honey hunting activities. To support these applications, we installed a solar home system (SHS) as a charging station for the GPS units and the digital cameras.

We have tried to make the whole process transdisciplinary from conceptualization until implementation. During the conceptualization phase of the project under which this baseline mapping approach belongs to, the lead researcher shaped the proposal through consultations with NTFP-EP in the Philippines and NATRIPAL, which are gatekeepers of the Tagbanua community. Administrative requirements such as permits were addressed alongside project concept development. Upon approval of the project concept by the supervisors and funding agency, the lead researcher (hereinafter called field researcher) complied with a health and security check and an ethical clearance from the research institute. These pre-field requirements emphasized the importance of respecting codes of cultural behavior in the research area among other things. Prior to engaging with the Tagbanua community in Sagpangan, the field researcher also conducted meetings with NTFP-EP Philippines in Quezon City, National Capital Region and with NATRIPAL in Puerto Princesa, Palawan. Letters were sent to the National Commission on Indigenous Peoples (NCIP), the local government (village level), and to the indigenous Tagbanua peoples organization SAKTAS. Ideally, all three should have given permission before field research could commence. However, the permission of SAKTAS is of prime importance and the field component of the research commenced once the SAKTAS president provided her permission on behalf of the community members.

In implementing the baseline mapping, a two-step social preparation, which lasted for eight months, and a two-phased technical preparation was vital in the deployment of the technologies within the forest community required. The two-step social preparation involved trust building between the forest community members and the field researcher, which paved the way for informal consultations. The two-phased technical preparation invited members of the Sagpangan village to voluntary participate in knowledge and skills transfer trainings.

4.3.1 Two-step social preparation

One of the critical ingredients for undertaking PGIS is trust between different groups and individuals (Corbett et al. 2006). In our study, trust building processes between the community and the field researcher started in June 2014, which was eight months before the actual PGIS field work. Homestays and interviews were conducted on a bi-weekly basis, with the field researcher presenting and discussing the project and its objectives with the community members.

During the first ten interviews of the field researcher, she was accompanied by at least one community member who is well known in the community. This arrangement facilitated a trust building process necessary for the field researcher to establish intimate relationships with other community members as well as snowball sampling of key informants. After two months, the field researcher moved from a position of stranger to a welcome visitor through a "hanging out" process, which involves meeting and conversing with community members over an extended period of time (Bernard 1994; DeMunck and Sobo 1998; Kawulich 2005). This establishment of trust facilitated the social preparation, which primed the community for the introduction of external technologies. The first step in social preparation was conducted in January 2015 through an informal door-to-door consultation in Sagpangan village in order to gauge the community members' interest to engage in the project and learn how to use the new devices or technology. The background and purpose of the project was explained and a sample of the GPS device model Garmin eTrex 20 was shown during the informal consultation. The second step was a consultation with NATRIPAL regarding conducting a technical training in Sagpangan. The NGO facilitated the formal notification and invitation of local government authorities to the upcoming training in the village. Through this two-step social preparation we were able to gauge the community's willingness to jointly work on the project and their readiness to accept new technologies and external intervention.

4.3.2 Two-phased technical preparation

The first phase of the technical preparation involved a thorough consultation with a technical expert, who identified Garmin eTrex 20 to be the most appropriate GPS unit for participatory mapping of giant wild honey bee nests. Additionally, water- and shock-proof Nikon S32 digital cameras were also acquired. A 20 Watt peak SHS was designed by a local solar engineer to supply the electricity needed for recharging the GPS units and the digital cameras. The second phase of technical preparation comprised the actual deployment of the SHS in Sagpangan village and the distribution of GPS and digital camera units for a three-day technical training in February 2015. The training was attended by thirty community members and was conducted in one of the houses of the participants. The medium of instruction was the national language Filipino, which all of the community members were familiar with in addition to having a first language of Tagbanua. The training covered topics on the Garmin eTrex 20 GPS unit and its features on satellites, waypoints, tracks, area calculation, and trip computer. Unfortunately, none of the pre-programmed languages on the GPS device are spoken in the community. As some of the community members are familiar with the English language, it was used as the language setting for the GPS units. The Nikon S32 digital camera was briefly introduced but a separate training was also conducted alongside a refresher course on the use of the GPS units in April 2015 in time for the start of the honey season. After the training, the GPS units, the digital cameras, and the SHS were left in the care of the community. They were free to use the devices according to their needs or requests, for e.g. to practice taking waypoints, take private photos, or to re-charge personal devices such as mobile phones through the SHS.

4.3.3 Mapping proper

A protocol for the community mapping was agreed upon during the second phase of the technical preparation. The GPS and digital camera units were issued identification numbers and sign-up sheets were given to a research assistant based in Sagpangan village. Whenever a group of hunter-gatherers went to the forest to gather wild honey, they could take a GPS and digital camera unit with them to map wild honey bee nests. Upon return from the forest, they wrote their name and the unique ID number of their GPS and digital camera units on the sign-up sheet and returned the devices to the research assistant in the village. A signature on the sign-up sheets attested that they have returned the devices in good condition. The research assistant then checked the respective GPS and digital camera units and re-charged their batteries at the SHS if needed. The GPS mapping of wild honey bee nests was conducted during the honey flow season from April 2015 to June 2015.

4.3.4 Baseline map creation

After the honey flow season, data from the GPS units and digital cameras were downloaded. The Tagbanua honey hunters mapped a total of 31 wild honey bee nests. The GPS coordinates of the wild honey bee nests were processed through ArcGIS 10.1 to create a map of wild honey bee nests (Figure 4.1) marked by the wild honey hunters and gatherers. Two GPS devices, one digital camera, and the SHS were left in the community for subsequent use.

4.4 Results and discussion

The two-step social preparation process was crucial in obtaining the acceptance of new technology in the area. Even after trust was built between the field researcher and the community, it was important to conduct informal door-to-door consultations to introduce the new devices to the community. This elicited both curiosity as well as reluctance towards the new technology especially the GPS units. The community members were at ease with digital cameras and SHS since they had previous experience with these devices. Some community members have previously seen a GPS device, but none had the chance to use it. Through the two-phased technical preparation, the community learned about the devices. The participants initially expressed reservations after discovering the cost of each GPS unit, but they eventually became fully comfortable with using the devices once they had the chance to hold and use these during the technical training.

During the course of the technical training, some of the community members were able to conceptualize other uses for the GPS units in addition to mapping the wild honey bee nests. They were particularly interested in using the GPS units in mapping their ancestral land through the GPS feature area calculation and taking note of mining concessions in their ancestral land through the GPS feature waypoints. This underscores the ability of the Tagbanua community to pursue self-determination and self-direct informal learning (Bockstael and Watene 2016). Mainstream education and development research often claim that only formally educated people can facilitate development and rural transformation; results of our collaborative mapping, however, show that it may also be possible with non-formal learning (Robinson-Pant 2015).

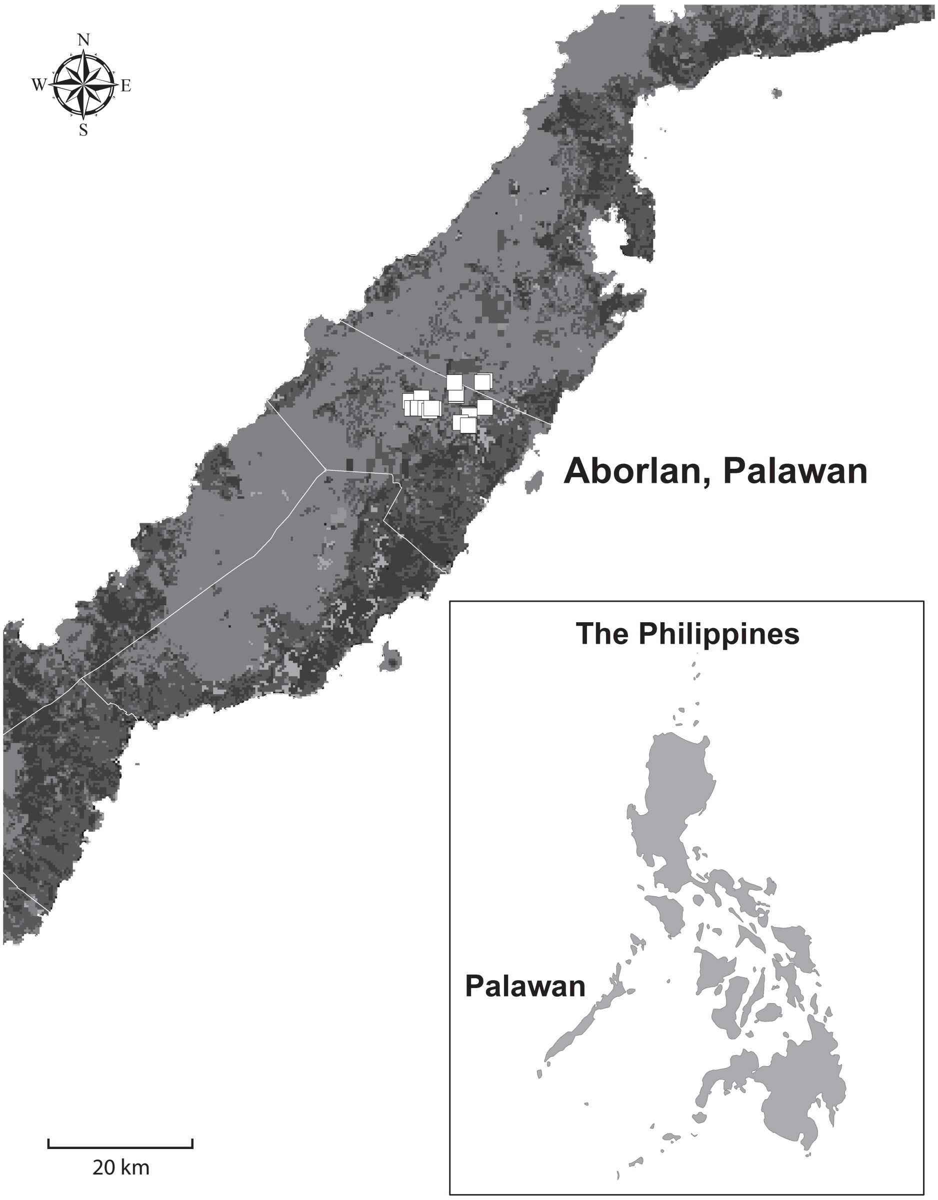

Figure 4.1 *Apis dorsata* Fab. in Sagpangan. Wild honey bee nests (white boxes) mapped by wild honey gatherers during the honey season in 2015.

The different sectors of the Tagbanua community, i.e. men, women, and youth, were well represented during the social and technical preparations. Despite wild honey being traditionally hunted and gathered by men (Crane 1999; Shackleton et al. 2011a), women and children still play a role. The transmission of wild honey hunting and gathering through generations is achieved through intergenerational apprenticeship and experiential learning (Ronoh et al. 2016). Once the children reach their teenage or marrying years, their primary concern is to find adequate means of livelihood for their family. Women, on the other hand, are involved in the consolidation of gathered honey or in the traditional processing of honeycombs through squeeze extraction of honey. This multisectoral participation not only exemplifies generation- and gender-balanced participatory learning but also decision-making. Due to budget and logistical constraints, the project could only sponsor 30 participants and the community members decided among themselves who should participate. Community leaders confirmed the decisions reached by the community members and did not intervene during the selection process. These community members also used this process to agree on the use rights on the devices after the project was concluded: a member of the community was designated as the custodian of the SHS, GPS and digital camera units, which the other community members could use if they wish to do so.

4.4.1 The role of trust in participatory learning and collaborative action

Entrusting the community with the GPS units for use without external supervision during the wild honey flow season from April to June 2015 allowed for a longer-term community involvement and enabled the community to “learn by doing.” By fully entrusting the devices to the community, their confidence in handling complex technology increased. Consequently, the more they used the devices, the more proficient they became in using the various and complex functions of the devices.

According to English-Lueck et al. (2002) issues of trust emerge when successful work depends on the kindness of strangers. In this study, a reciprocal establishment of trust was crucial in fulfilling the research objectives. Similar to the Crow (Apsáalooke) Indian Nation, the Tagbanua community is aware when strangers come to their village and word spreads quickly regarding the identity, the purpose of visit, and the activities of the strangers (Christopher et al. 2008). Bi-weekly homestays and interviews by the field researcher in Sagpangan showed what Christopher et al. (2008) describes as a presence that builds trust and communicates broader interest in the community beyond personal or scientific gain. Eight months of trust building with the community is a time-consuming but highly rewarding process, which can only result from long-term commitment (Ross et al. 2015). Consequently, the community entrusted data about their area to the field researcher in the hopes that this data would eventually benefit their community in one way or another.

The field researcher, on the other hand, also developed trust and confidence on the community members’ ability to learn new technologies in a short period of time and their willingness to collaborate and collect data. The community managed to learn how to use the GPS in only three days despite a lack of formal schooling and understanding of any of the languages pre-programmed on the GPS. The wild honey hunters and gatherers used the devices and collected GPS points of the giant wild honey bee nests on their own accord without any external incentives.

4.4.2 Transdisciplinarity in participatory learning and collaborative action

The participatory and collaborative approaches used in mapping giant honey bee nests helped the project in achieving transdisciplinarity, which is a research process generally characterized by mutual learning and integration of science and society (Jahn et al. 2012). This process rests on extended knowledge production among a variety of actors not just from different disciplines but also from those outside of academia on issues or problems that arise from a local context (Mobjörk 2010; Lang et al. 2012). In order to achieve adequate problem orientation and ensure integrative results, research on social-ecological systems should always use a transdisciplinary mode of operation (Campennì 2016).

The collaboration of scientific researchers with indigenous Tagbanuas on mapping the giant honey bee nests exemplified integrated learning and knowledge production. It closely followed what Bergmann et al. (2012) describe as the different dimensions by which integration occurs in a transdisciplinary context. These dimensions emphasize that integration in transdisciplinary research processes – as normally understood by scientists – is neither primarily nor exclusively limited to knowledge (Bergmann et al. 2012).

In this project, the *communicative dimension*, aimed at developing mutual understanding and communication, was built on a process structured by a two-step social preparation and the two-phased technical preparation. By introducing common terminologies such as GPS, digital camera, and SHS, a common discourse between the researchers and the participating Tagbanuas was established. The usage of English was also modified to suit the understanding of the participants. For example, the participants pronounced "save" (one of the options on the GPS devices) in two syllables, i.e. "sa-ve." To facilitate understanding, the trainers adopted this pronunciation during the technical training.

The *social and organizational dimension*, aimed at recognizing while at the same time correlating the different interests of parties, was addressed during the two-phased technical preparation. The field researcher, the trainer, and the participants demonstrated an understanding of each other's goals and a willingness to learn from each other. The community members showed conscious leadership by independently thinking of further uses of the new technologies other than the proposed mapping of giant wild honey bee nests.

The *cognitive-epistemic dimension*, aimed at distinguishing and linking diverse knowledge systems to jointly develop methods, was emphasized as the mapping proper commenced. Practical knowledge of Tagbanuas in hunting for wild honey bee nests was linked to the technical know-how of the researchers through the use of the new technologies. This knowledge linkage resulted in a new approach to participatory forest resource mapping – one that is conducted in a voluntary and autonomous manner and integrated in day-to-day activities of the community members.

4.4.3 Improving participatory research through salient information

Participatory research approaches provide legitimate (i.e. produced in a fair and inclusive manner) and credible (i.e. scientifically plausible and technically adequate) information (Cash et al. 2002). However, the relevancy or saliency of research results to stakeholders such as community members or local governments is often overlooked. For example, subsistence livelihood is of primary importance to the indigenous Tagbanua community of Sagpangan. While the SHS directly provides a supplementary source of energy and the digital cameras allow them to capture memories, the GPS units and their new skill of operating these have limited avenues for translation to much-needed income since the indigenous community is still under a labor economy unlike the knowledge economy of research. Our participatory approach being integrated into the daily routine of the community members has minimized the negative impact of external trainings to local livelihoods. Unless trainings compensate participants for the opportunity cost of lost labor, participatory approaches need to be implemented in a manner that does not disrupt the workday of participants and increases saliency of research results.

4.5 Conclusion

The introduction of new technologies in rural areas such as indigenous forest communities requires sound and long-term social and technical preparation. A community's acceptance and ownership of a new technology requires ample time and social preparation may stretch into months apart from a technical preparation phase. In the case of an indigenous Tagbanua community in Palawan, the trust building that started eight months prior to the commencement of the social and technical preparation helped in securing the community's acceptance and ownership of the new technology. Social preparation revealed both curiosity and reluctance of the community in using new technologies, and these were addressed during technical preparation. The technical preparation benefitted from prior consultation with technology experts and employing trainers who were both knowledgeable and experienced in teaching rural communities. These preparations as well as the community's openness to new technology are important when implementing participatory approaches on a period longer than one month without external intervention or supervision.

Longer-term participatory approaches that respect autonomy of rural communities result in increased confidence of the community in learning and handling new technologies. In the case of the indigenous Tagbanua in Palawan, despite low levels of formal education, community members were able to learn how to use GPS and digital camera units within three days and eventually operate the equipment on their own without any supervision during the mapping proper.

The mapping exercise exemplified transdisciplinary research and its dimensions by producing knowledge not only from researchers but also from the local community. The process before the mapping proper showed how the communicative, social and organizational, and cognitive-epistemic dimensions of transdisciplinarity could be integrated. Deploying a new technology in rural communities can greatly benefit from a transdisciplinary approach and from building mutual trust between researchers and the community. Our approach was only employed in a one-year direct engagement with a rural community and we recommend future research to use the approach on long-term projects. We highly encourage that long-term natural resources management efforts take advantage of transdisciplinary approaches where participatory learning and action paves the way for autonomy and independent thinking among stakeholders while having a non-disruptive impact on their daily lives and taking caution to produce results, which are not only legitimate and credible, but also useful and relevant in informing decisions and choices of stakeholders.

5 Ecological changes and local knowledge shifts in the Tagbanua honey hunting community

5.1 Abstract

One of the traditional livelihood practices of indigenous Tagbanuas in Palawan, Philippines is wild honey gathering from the giant honey bee. In order to analyze the linkages of the social and ecological systems involved in this indigenous practice, we conducted spatial, quantitative, and qualitative analysis on field data gathered through GPS mapping, community surveys, focus group discussions, and key informant interviews. We found that only 24% of the 251 local community members surveyed could correctly identify the giant honey bee. Inferential statistics showed that a lower level of education and higher household vegetation contribute to correct identification of the giant honey bee. Spatial analysis revealed that mean NDVI of sampled nesting tree areas has dropped from 0.61 in the year 1988 to 0.41 in 2015. This reduction on vegetation cover may contribute to reduced bee-human interactions and may also be an indication that commercializing non-timber forest products is not fulfilling its objective of development alongside conservation.

5.2 Introduction

Indigenous community forests exemplify complex systems of people and nature. Community forests provide benefits to people through their multiple ecosystem services. Through their traditional livelihoods, indigenous forest communities directly depend on and interact with forests. When threats of deforestation became widespread worldwide, the protected area approach became a reflex response by conservationists. Operating from a protectionist argument, forest protected areas without any human activity were seen to have a higher probability of conservation success compared to areas that also involve community development and participation (Wilshusen et al. 2002). Apart from raising issues of forced eviction of forest peoples, the protected area approach also led to a dilemma pitting conservation against human development especially in community forests (UNGA 2016). However, an alternative approach suggests that conservation efforts may also be successful in the presence of human occupants by marketing NTFPs (Carter et al. 2012); this has been seen as a strategy to simultaneously achieve both livelihood and conservation goals in forest communities, which is the aim of ICDPs (Garnett et al. 2007). As research interest on NTFPs rapidly grew during the 1990s, NGOs and multilateral agencies also quickly established programs to support commercialization of NTFPs (Sills et al. 2011). Initial enthusiasm over this strategy eventually waned due to its seemingly limited conservation and development gains, but NTFPs continued to be used for subsistence and local or regional trading (Shanley et al. 2015). Despite a number of studies on NTFPs in the past two decades, basic research is still needed on the ecology, use, and management of NTFPs as well as on its production, policies, trade, and cultural importance (Sills et al. 2011; Shanley et al. 2015).

Harvesting of NTFPs for local and household needs is frequently nondestructive, but for commercial purposes, it can go in any direction (Shackleton et al. 2011b).

Ultimately, commercial exploitation of NTFPs needs to prove its sustainability by showing that livelihood improvement can go hand-in-hand with improved natural resource management and biodiversity conservation (Shackleton et al. 2011b). This remains a very important question, as the largest net forest loss worldwide is associated with increasing rural populations, who are still lagging behind in the race against extreme poverty (FAO 2016; IFAD 2016). Given these prevailing trends in deforestation and poverty, we aimed to study the dynamics of an indigenous community in the Philippines and its forests prior to the transitioning of its wild honey gathering from a subsistence practice into its current commercial endeavor. The direct dependence of indigenous Tagbanuas on their community forest highlights the need to keep their local ecosystem productive and able to provide ecosystem services essential for the community's livelihoods. This challenge has given rise to several new approaches and types of science; an example is sustainability science, which is at the forefront of understanding the interactions between nature and society (Gibbons et al. 1994; Funtowicz et al. 1999; Kates et al. 2001; Biggs et al. 2015). In order to understand these nature-society interactions in the Tagbanua indigenous community forest, we pursued three objectives in our research: first is to assess the current knowledge and practices of both hunter and non-hunter members of the community on the giant honey bee; second is to identify changes in vegetation cover pre- and post-CFE establishment in areas where the giant honey bee are hunted; and third is to evaluate the contribution of wild honey hunting to natural resource management.

Our paper makes use of an SES perspective to facilitate better understanding of the linkages between the indigenous Tagbanua, their traditional practice of wild honey hunting, and the market economy they currently participate in. Understanding the dynamics of this wild bee-human system becomes increasingly important as interactions between the Tagbanuas and their ecosystems increase in scale, scope, and intensity (Fischer et al. 2015). We analyze these dynamics through qualitative and quantitative approaches, which we present in the following chapter. Subchapter 5.4 enumerates our findings, and in subchapter 5.5 we discuss how the interaction of social and ecological factors leads to knowledge shifts in the community. We conclude this chapter in subchapter 5.6 by highlighting the complexity of SES and how feedbacks play an important role in the conservation the wild bee-human system.

5.3 Methodology

Following the framework of Berkes and Folke (2002) on linkage of ecosystem and local management, we applied both qualitative and quantitative approaches on the social and ecological factors of the Tagbanua-wild bee system. These were implemented through field and desktop research. The field research component was conducted from June 2014 to June 2015 in Sagpangan, an indigenous Tagbanua village settlement in Aborlan, Palawan, Philippines. Consultations in the form of focus group discussions were conducted before and after field research with different community members. The initial consultation presented the hypothesis adopted by the research, while the exit consultation presented a summary of the results obtained from the field research. Both consultations made use of visual aids on Manila paper.

To address objective one, in-depth key informant interviews were conducted with 20 wild honey hunter-gatherers and with eight staff members and workers from the NGOs NTFP-EP Philippines and NATRIPAL regarding wild honey hunting and its enterprise. Similarly, a survey questionnaire was used to ascertain the wild honey bee knowledge and practices of 251 non-hunter-gatherers from the community (see English version of the questionnaire in Appendix II). Both in-depth interviews and survey questionnaire methods included an exercise where photos of all known honey bees summarized in the book of Koeniger et al. 2010 were shown to respondents and they were asked to identify the common names of the species. The in-depth interviews were conducted prior to the community survey in order to identify the important areas of knowledge in the wild honey enterprise that should be included in the survey questionnaire. The survey questionnaire was adjusted based on knowledge patterns with implications for sustainability of the wild honey enterprise, which emerged from the in-depth interviews. Participant observation was employed bi-weekly and during one of several multi-day wild honey gathering trips where 12 honey samples and 31 GPS coordinates were taken by the wild honey hunter-gatherers.

To fulfill objective two, Landsat 4-5 TM and Landsat 8 ORI/TIRS images of Aborlan, Palawan during the years 1988, 1998, 2004, and 2015 were downloaded from the United States Geological Survey EarthExplorer website. Information on the images can be found in Appendix II. The images were analyzed through QGIS 2.16 for their normalized difference vegetation index (NDVI) through the following equation:

$$NDVI = NIR - Red \div NIR + Red \tag{5.1}$$

NIR stands for near infrared; Landsat 4-5 TM images have band 4 as NIR and band 3 as Red while Landsat 8 ORI/TIRS images have band 5 as NIR and band 4 as Red. The community forest area only has evergreen trees, which has green leaves throughout the whole year (unlike deciduous trees) and, therefore, has more or less accurate representation of the vegetation cover at any time period within the year. Results of the NDVI were analyzed along the GPS coordinates of wild honey bee nests and interview participant community households through the point sampling tool plugin in QGIS 2.16.

Data from focus group discussions, in-depth key informant interviews, and participant observation were analyzed through coding using QDA Miner Lite. The survey questionnaires were coded based on the multistep knowledge development process (Table 5.1), which was first proposed by Hirsch-Hadorn et al. (2006) and further refined by other researchers (Jerneck et al. 2010; Brandt et al. 2013; Partelow and Winkler 2016). Descriptive statistics on results of the survey questionnaires were run through R version 3.3.1 and inferential statistics were performed through Stata 14.2. We conducted χ^2 and Fisher's exact tests to determine which categorical system knowledge variables on Table 5.1 were significantly correlated with a correct identification of at least one honey bee species. We then conducted a logistic regression including age and residence years (continuous variables) in addition to the categorical variables. After confirming the variable strongly correlated with correct identification of bees, we verified the results by looking at the variance inflation factor (VIF) of the predictor variables and thereafter running a logistic regression without the variables with a VIF > 10.00 (i.e., role in household, age, and marital status). To test the robustness of this data, we performed bootstrapping at

1,000 (Table 5.5) and 10,000 replications (Table 5.6) with seed one, two, three, four, and five. We tried to understand which of the respondents were associated with the predictor variable by conducting a χ^2 test between the predictor variable and the ethnicity of the respondents. We also wanted to understand whether the different levels of vegetation are correlated with the correct identification of honey bees by the non-hunter gatherer members of the Tagbanua community. To do this, a χ^2 test was conducted for data collected in the year 2015. We classified the NDVI values to low (0.127 – 0.209) and high (0.210 – 0.554) vegetation cover (USGS 2015) and conducted the χ^2 test with the identification of bees. We also conducted a repeated-measures ANOVA and mixed-effects linear regression to determine whether the difference of NDVI values were statistically significant. The mixed-effects linear regression has the advantage of retaining subjects with missing time points and estimating additional residual covariance structures compared to a repeated-measures ANOVA (Lazic 2010; Mitchell 2015).

Table 5.1 Multistep knowledge variables in survey questionnaire. Systems knowledge variables describe components of the social system. Target knowledge defines perspectives of the social system for the ecological system.

Systems knowledge	Target knowledge
Ethnicity	Current use of honey
Number of residence years in community	Current practice of entomophagy
Age	Knowledge of government regulation
Gender	Use and treatment of land
Marital status	Use and treatment of animals
Presence of a hunter gatherer/s in family	Alternative livelihood to farming
Role in household and community	
Level of formal education	
Correct identification of honey bees and their life characteristics	
Number of household members	

5.4 Results

The qualitative and quantitative approaches used yielded information regarding local knowledge and practices on wild honey bees, their products, and their target and supporting matrix. Additionally, these approaches also provided information on institutions and external interventions. All this information contributed in forming a picture of the social and ecological connections and feedbacks within the system of giant honey bee and indigenous wild honey hunter and gatherers.

A summary of the characteristics of the 251 non-hunter gatherer respondents can be found on Figure 5.1. Most of the respondents were female of Tagbanua ethnicity and have low levels of formal education. Half of the respondents are aged between 31-50 years. Most of those interviewed do not have any honey hunter-gatherers in their immediate family.

5.4.1 Local knowledge on wild honey bees

Out of the 251 non-hunter-gatherers surveyed in the community, only 72 or 29% were able to identify at least one of the honey bees in the illustration shown on Figure 1.6. Conversely, all of the 20 wild honey hunter-gatherers interviewed could correctly identify the giant honey bee. Of the 72 non-hunter-gatherers who positively identified at least one honey bee species, most (85%) correctly identified the giant honey bee, while only a minority (15%) were able to identify the Eastern honey bee. Only five respondents were able to correctly identify both species and all, except for one respondent, were of Tagbanua ethnicity. The other respondents who were only able to identify one species were mostly Tagbanuas (55%). The others had mixed-ethnicity or were non-indigenous (45%). Most of those who answered correctly (58%) had a low level of formal education, i.e., no formal education or elementary level education. The others had either a medium level of education, i.e., having reached high school or vocational level (31%) or college education (10%).

In determining which of the system knowledge variables was significantly correlated with a correct identification of at least one honey bee species, results of our χ^2 and Fisher's exact tests show that the level of education was significantly correlated at $\alpha = 0.01$ with correct identification of bees (Table 5.2). The logistic regression conducted with the continuous variables (age and residence years) confirmed that the level of education predicts the likelihood of a correct identification of at least one honey bee species at $\alpha = 0.05$ at $p = 0.024$ (Table 5.3). By running a logistic regression excluding the predictor variables role in household, age, and marital status (i.e., with VIF > 10.00), we confirmed that the level of education strongly correlates with correct identification of bees ($\alpha = 0.01$) at $p = 0.012$ (Table 5.4).

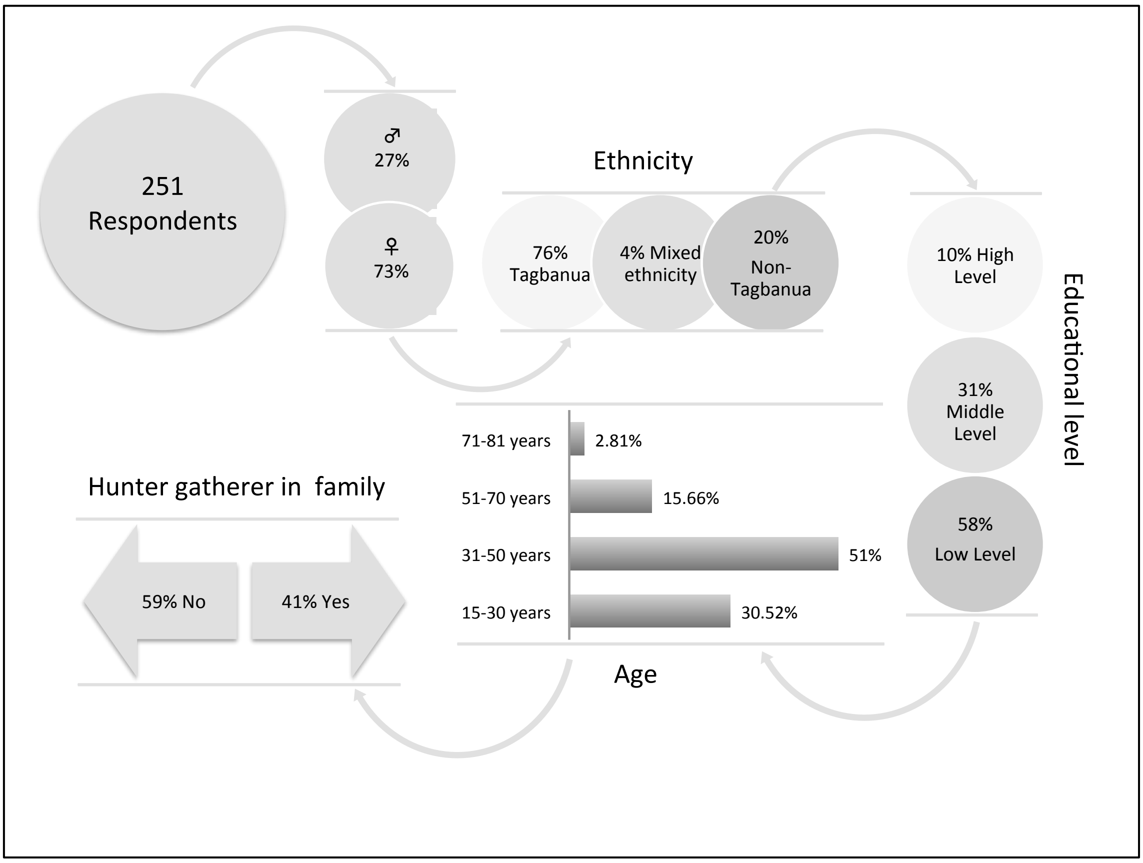

Figure 5.1 Summary of demographic data of respondents surveyed. Majority of the respondents are female, of Tagbanua ethnicity, with low level of formal education, aged between 31-50 years, and have no honey hunter-gatherer as an immediate family member.

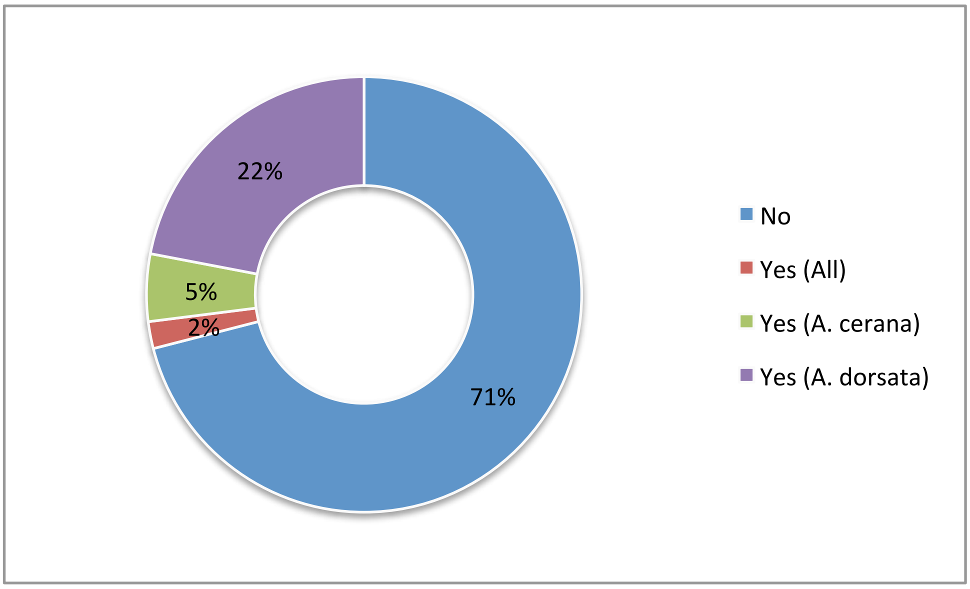

Figure 5.2 Identification of giant and Eastern honey bees by non-hunter gatherer respondents. The majority of the respondents (71%) could not correctly identify either the giant honey bee or Eastern honey bee. Only 29% could correctly identify either giant or Eastern honey bee.

To test the robustness of level of education as predictor of correct identification of bees, we performed bootstrapping at 1,000 (Table 5.5) and 10,000 replications (Table 5.6) with seed one, two, three, four, and five. Both bootstrapping operations remained highly significant ($\alpha = 0.05$) at $p = 0.005$, showing that the level of education as predictor of correct identification of honey bees is not data-dependent and would hold true in replications of this study. The odds ratio shows that for every unit increase in education, the log odds of correctly identifying either or both Asian or giant honey bee species is 0.46.

Table 5.2 Results of χ^2 and Fisher's exact tests on education and identification of bees. The majority of respondents who correctly identified the giant honey bee and/or Eastern honey bee have low levels of formal education. Results of inferential statistics show a strong correlation between low level of formal education and correct identification of giant honey and Eastern honey bees.

Formal educational attainment	Correct identification of bees		Total
	No	Yes	
High	24	2	26
	92.31	7.69	100.00
Medium	64	14	78
	82.05	17.95	100.00
Low	101	45	146
	69.18	30.82	100.00
Total	189	61	250
	75.60	24.40	100.00
Pearson chi^2(2) = 8.9585 Pr = 0.011 Fisher's exact = 0.010			

Table 5.3 Results of logistic regression on categorical and continuous research variables. Among all the system knowledge variables, the level of education is the only significant predictor of correct identification of giant and Eastern honey bees.

Logistic regression			Number of obs = 247 LR chi2(9) = 14.89 Prob > chi2 = 0.0940 Pseudo R2 = 0.0539			
Log likelihood = -130.62254						
Correct identification	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Ethnicity	1.488213	.7008775	0.84	0.399	.5912755	3.745765
Marital Status	.6980414	.4128872	-0.61	0.543	.2189781	2.225162
Role in household	2.094084	2.040319	0.76	0.448	.3102035	14.13648
Educational level	.5118499	.1515823	-2.26	0.024	.2864591	.9145819
Role in community	1.196268	.2414553	0.89	0.375	.8054186	1.776787
Residence in years	.9801283	.0144614	-1.36	0.174	.9521903	1.008886
Age	1.021556	.017998	1.21	0.226	.9868824	1.057447
Gender	1.227123	.407509	0.62	0.538	.6400542	2.35266
Hunter gatherer	1.204451	.3875344	0.58	0.563	.6410822	2.262898
_cons	.0053411	.0122429	-2.28	0.022	.0000598	.4772781

Table 5.4 Results of logistic regression excluding variables with VIF > 10.00. The low level of education remains strongly correlated with correct identification of giant and/or Eastern honey bees.

Logistic regression			Number of obs = 248 LR chi2(6) = 12.26 Prob > chi2 = 0.0563 Pseudo R2 = 0.0443			
Log likelihood = -132.21792						
Correct identification	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Ethnicity	1.253057	.5527487	0.51	0.609	.5278236	2.974767
Gender	1.271266	.4179597	0.73	0.465	.6673957	2.421529
Hunter gatherer	1.105507	.3470471	0.32	0.749	.5975128	2.045387
Role in community	1.149533	.2278663	0.70	0.482	.779457	1.695317
Educational level	.4822329	.1401854	-2.51	0.012	.2727798	.8525142
Residence in years	.9921252	.0099637	-0.79	0.431	.9727876	1.011847
_cons	.527453	.557833	-0.60	0.545	.0663675	4.191914

Table 5.5 Results of bootstrapping at 1,000 replications. Low level of formal education remains a significant predictor of correct identification of giant and/or Eastern honey bees at 1,000 replications

Logistic regression			Number of obs = 250 Replications = 1,000 Wald chi2(1) = 7.96 Prob > chi2 = 0.0048 Pseudo R2 = 0.0355			
Log likelihood = -133.97408						
Correct bee identification	Observed Odds Ratio	Bootstrap Std. Err.	z	P>|z|	Normal-based [95% Conf. Interval]	
Educational level	.4627419	.1263628	-2.82	0.005	.2709554	.7902779
_cons	.9716238	.3845774	-0.07	0.942	.4472857	2.110626

Table 5.6 Results of bootstrapping at 10,000 replications. Low level of formal education remains a significant predictor of correct identification of giant and/or Eastern honey bees at 10,000 replications.

Logistic regression Log likelihood = -133.97408			Number of obs = 250 Replications = 10,000 Wald chi2(1) = 7.80 Prob > chi2 = 0.0052 Pseudo R2 = 0.0355			
Correct bee identification	Observed Odds Ratio	Bootstrap Std. Err.	z	P>|z|	Normal-based [95% Conf. Interval]	
Educational level	.4627419	.1277038	-2.79	0.005	.2694207	.7947795
_cons	.9716238	.38333	-0.07	0.942	.4484125	2.105322

Table 5.7 Results of χ^2 test between ethnicity and formal educational attainment. There is a strong correlation between low level of formal education and indigenous Tagbanua ethnicity.

Ethnicity	Formal educational attainment			Total
	Low	Medium	High	
Non-Tagbanua	17	31	11	59
	28.81	52.54	18.64	100.00
Tagbanua	129	47	15	191
	67.54	24.61	7.85	100.00
Total	146	78	26	250
	58.40	31.20	10.40	100.00
Pearson chi^2(2) = 27.8963 Pr = 0.000				

A χ^2 test conducted between the ethnicity of the respondents and their level education shows a highly significant result p = 0.00 (rounded to three significant digits) (Table 5.7) that most respondents of Tagbanua ethnicity are associated with low level of education, while non-indigenous or mixed ethnicity respondents are associated with higher levels of education.

5.4.2 Natural resource characteristics and use practices

The natural resources involved in the wild bee-human system are the community forest with the wild bee nesting trees, nectar sources, and products. We calculated the NDVI in the forest area where nesting trees are found and in the land area where non-hunter gatherer respondents of our interview survey in 2015 live. These residential areas have an NDVI of 0.127 – 0.554 with a mean value of 0.378 (Year 2015 on Table 5.8), while the areas where nesting trees were found have an NDVI of 0.156 – 0.539 with a mean value of 0.409 (Year 2015 on Table 5.9). The mean NDVI of nesting trees and residential areas do not differ significantly.

Table 5.8 Summary of multi-year NDVI values for community households. There is a decline of mean NDVI from the year 1988 to 1998 and 2004 to 2015.

Year	Mean	Std. Deviation	Minimum	Max
1988	.5638409	.148638	.2043	.75
1998*	.3750473	.2065226	.05882	.7027
2004	.4368082	.1464191	.16031	.70642
2015	.3775548	.1121188	.12696	.55398

*Negative values were excluded

Table 5.9 Summary of multi-year NDVI values for nesting tree areas. There is a decreasing trend of mean NDVI from the year 1988 to 2015.

Year	Mean	Std. Deviation	Minimum	Max
1988	.6083335	.1352543	.05051	.74324
1998	.5250758	.076344	.30000	.65854
2004	.4336258	.2268069	.05929	.728
2015	.4085065	.1109285	.15638	.53891

Analyzing the correlation between these different levels of vegetation with the correct identification of honey bees by the non-hunter gatherer members of the Tagbanua community through a χ^2 test returned results that are approaching but fails to achieve conventional significance (α = 0.10) χ^2 = 0.127 (Table 5.10). The results, however, show that 94% of the respondents who correctly identified the giant honey bee live in an area with high vegetation.

Table 5.10 Results of χ^2 test between NDVI and identification of bees. There is a significant correlation between correct identification of giant honey bees and high NDVI or vegetation cover.

NDVI	Correct identification of bees				Total
	No	Yes (both spp.)	Yes (A. cerana)	Yes (A. dorsata)	
Low	16	1	3	3	23
	69.57	4.35	13.04	13.04	100.00
High	161	4	8	50	223
	72.20	1.79	3.59	22.42	100.00
Total	177	5	11	53	246
	71.95	2.03	4.47	21.54	100.00
Pearson $chi^2(3)$ = 5.7096 Pr = 0.127					

We also calculated the NDVI values from relatively cloud-free Landsat 4-5 TM images of June 1988, January 1998, and February 2004 (Figure 5.3) of the nesting tree and community household areas alongside the NDVI values of May 2015. The mean NDVI values decreased from 1988 to 1998 to 2004 to 2015 for nesting tree areas. In community households, the mean NDVI values decreased from 1988 to 1998 but increased in 2004 and thereafter decreased again in 2015. The results of repeated-measures ANOVA (Table 5.11) show a statistically significant decrease of vegetation within community households throughout the years. This is consistent with the results of the mixed-effects linear regression (Table 5.12) for community households and nesting tree areas. Full results of all the analyses are available at Appendix II.

Table 5.11 Summary of repeated-measures ANOVA results. The decrease of vegetation in community households and honey bee nesting areas from the year 1988 to 2015 is statistically significant.

Area	α	F	p
Community households	0.001	$F_{(3, 735)} = 242.52$	0.000 (rounded)
Honey bee nesting areas	0.001	$F_{(3, 90)} = 14.06$	0.000 (rounded)

Table 5.12 Summary of mixed-effects linear regression. The decrease of vegetation in community households and honey bee nesting areas from the year 1988 to 2015 is confirmed as statistically significant.

Area	α	Wald $\chi 2$	p
Community households	0.001	Wald $\chi 2$ (1, N = 246) = 742.02	0.000 (rounded)
Honey bee nesting areas	0.001	Wald $\chi 2$ (1, N = 31) = 49.97	0.000 (rounded)

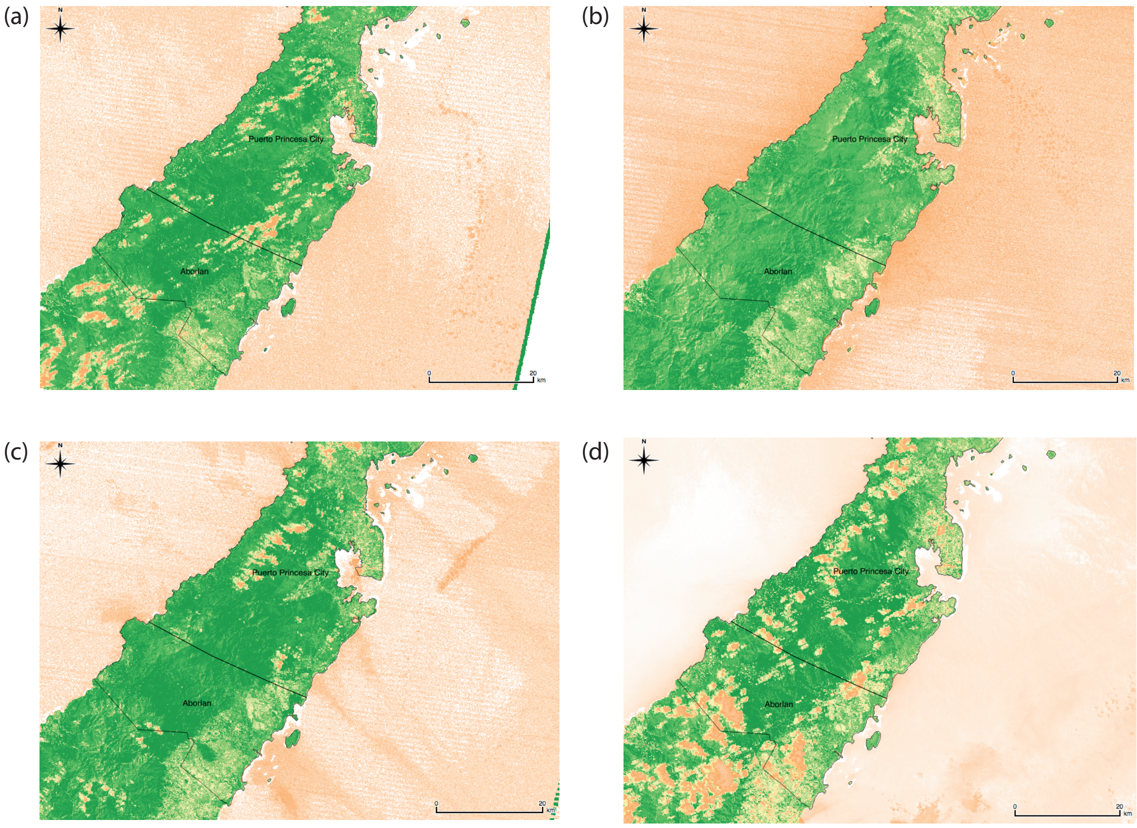

Figure 5.3 Results of NDVI analysis using QGIS 2.16 of Landsat images of Aborlan in Palawan. Each image represent the following years (a) 1988 (b) 1998 (c) 2004 (d) 2015. Only (b) has 0.00 cloud cover among all the images. (Data source: USGS EarthExplorer)

5.5 Discussion

5.5.1 Social-ecological connectivity and local knowledge

The giant honey bees and the indigenous Tagbanuas have a mutual interaction in their SES, showing connectivity, which is not limited to the spatial landscape but also includes the web of connections involving the different parts of the system (Dakos et al. 2015). The statistically significant relationships between correct identification of giant honey bees and vegetation and level of education show how both ecological and social components play a role in shaping local knowledge. While there is no data on the state of local knowledge on wild honey bees in the past, establishing the current state of local knowledge is important because it is used by societies in converting natural into human-made capital (Berkes and Folke 2002). As an information-intensive endeavor, managing ecosystem services and human well being relies on knowledge of the SES (Berkes et al. 2003; MEA 2005). One way of ensuring the availability of "best knowledge" is by promoting the integration of technical knowledge with indigenous, local, or traditional knowledge (e.g. Ballard et al. 2008; Molina and Neef 2016). Indigenous or traditional knowledge have been touted as, "holistic, functional, and adaptive" to changes in social and natural environment, and survives thousands of generations in contrast to scientific knowledge (Rist and Dahdouh-Guebas 2006). This does not seem to be the case with our results, which statistically show that indigenous and traditional knowledge on wild honey bees has not been passed on and has barely survived as local knowledge, given that only 24% of the non-hunter gatherer respondents could correctly identify at least one of the honey bees.

Indeed, indigenous knowledge systems have been over-optimistically presented as viable alternative ways of knowing, while scientific knowledge systems have been increasingly criticized (De Walt 1994; Rist and Dahdouh-Guebas 2006). Caution should be exercised in taking local knowledge as dogma or equating indigenous or traditional knowledge to local knowledge, since this knowledge has less time depth and is generated through observations of the recent local environment (Berkes and Folke 2002). It may not be as useful, for example, in extreme events under a changing climate if such changes have not yet been experienced before. Local or traditional knowledge is also incorporated in institutional learning on resource use, which is essentially memory of experience (Berkes and Folke 2002). Our results of correct identification of bees based on level of education and household vegetation show how direct experience with bees play a major role in shaping local knowledge and, consequently, institutional learning. With decreasing vegetation throughout the years, we have reason to believe that indigenous and traditional knowledge on wild bees has shifted to its current state because of decreased experience with and observation of bees. This has consequences not only for institutional learning but also in natural resource management of the ecosystem where wild bees belong.

5.5.2 Knowledge renewal through learning in social-ecological systems

Because of the complexity of SES, knowledge of its system is always partial and incomplete thereby requiring continual renewal as the system it represents changes (Cundill et al. 2015). This renewal has often been recommended in the form of learning, which is lexically defined as an activity or process of gaining knowledge or skill through studying, practicing, being taught, or experiencing something (Merriam-Webster 2016). Learning can, therefore, be actively sought (i.e. studying or practicing) or passively acquired (i.e. being taught or experiencing something). The wild honey hunters and gatherers actively learned from a network of indigenous honey hunters how to sustainably harvest wild honey by only taking the honey part of honeycombs and leaving the eggs and larvae intact. The adoption of this sustainable practice is neither due to depletion crisis nor ecological understanding (Berkes and Turner 2006), but rather due to the economic benefits of being able to harvest a second round of honey when the eggs and larvae have grown into adult bees. After this second round of honey harvest, some of the wild honey hunters and gatherers would take the whole honeycomb and eat the larvae per their traditional practice. Analyzed through the loop learning approach introduced by Flood and Romm (1996), the wild honey hunter and gatherers have reached single-loop learning, which comprises a change in skills, practices, or actions to meet set goals (Cundill et al. 2015). Progressing to double- or triple-loop learning would require a combination of active and passive learning, which should also be extended to non-hunter gatherer community members who may also play a significant role in resource and environmental management (Gadgil et al. 2003). On an individual level, unlearning has been positively seen as a means to encourage further learning, since existing knowledge or old behaviors are one of the biggest impediments to changing one's paradigm (Rogers et al. 2013; Srividya and Velayudhan 2016). However, on a community level, unlearning may prove to be harmful especially if local knowledge essential for sustainable resource management practices is unlearned.

5.5.3 Knowledge shifts from social and ecological factors

Local knowledge is deemed important in ecosystem management because it can either complement the general knowledge developed by professional science or it can challenge professional science's top-down prescriptions (Gadgil et al. 2003). The local knowledge on giant honey bees of non-hunter-gatherers in the Tagbanua community does neither of the two but, instead, cautions against collectivizing local knowledge and using it without any verification. This is not meant to discredit local knowledge, but rather to use its state of validity in analyzing the SES. As our results show, level of education and household vegetation significantly influence correct identification of wild honey bees by non-honey gatherers in the Tagbanua community. The importance of education cannot be overstated; it has been included in the Universal Declaration of Human Rights (UNGA 1948) before as well as in the present 2030 Agenda for Sustainable Development (UNGA 2015). May and Aikman (2003), however, brought up that construction and imposition of formal education may lead to de-legitimation of indigenous knowledge as well as their languages and cultures. May and Aikman (2003) further emphasize that there should be indigenous alternatives to state-run formal schooling, which is aimed at assimilation and homogenization. An indigenous young man from Palawan interviewed by UNICEF (2016) clearly articulated this problem by saying that,

> *"Many children in my community miss school because they help their parents during harvest season. I think schools for indigenous children should follow the calendar of their communities, and include classes on our language and culture."*

Formal education can pave the way to a better life for indigenous peoples, especially if it does not conflict with their culture and traditions. However, there should not only be integration of formal education and indigenous, local, or traditional knowledge (Koehler 2017) but also of indigenous way of living. Coupled with lack of culturally appropriate education, decreasing vegetation cover also amplifies the lack of knowledge on wild honey bees. The results show that 94% of those who correctly identified the giant honey bee lives in an area with high vegetation. The giant honey bee is an open nesting species, which cannot be domesticated in enclosed spaces such as the Langstroth box used in beekeeping (Crane 1999; Oldroyd and Wongsiri 2006; Koeniger et al. 2010). Similar to the case of locals living in the Nacimiento watershed in Spain (Iniesta-Arandia et al. 2014), we found that decreasing vegetation cover limits the presence of wild honey bees, thereby also limiting the opportunities for non-hunter-gatherers members to interact with the bees or experience wild honey hunting. This interferes with the development of local knowledge through direct experience, with options for learning confined to either studying or being taught about wild honey bees (Davis and Ruddle 2010; Iniesta-Arandia et al. 2014).

5.5.4 Towards a systems approach to integrated conservation and development projects

The decreasing NDVI values over the last 30 years may be an indication that NTFP gathering – or wild honey hunting in particular – has yet to reach its goal of improved natural resource management in the area of Aborlan, Palawan. This is not surprising, but is rather consistent with analysis of many ICDPs showing only limited success (Garnett et al. 2007). However, it should not take more than a quarter of a century, as is the case for wild honey hunting in Aborlan, to figure out that an intervention is not living up to its envisioned results. The tendency to make single-variable interventions without regard for their impact on other parts of the systems can lead to failure in reaching objectives or push a system to change without noticing the slow variables at work (Westley et al. 2002). Timely evaluation is fundamental to identifying these changes, but has often been neglected in natural resource management (Bellamy et al. 2001). The quality of evaluation is also wanting, and a substantial gap between theory and practice still remains (Wallace et al. 1995; Curtis et al. 1998; Bellamy et al. 1999; Bellamy et al. 2001). In addition, evaluation is often only conducted to fulfill donor requirements, failure of which may mean loss of support (Garnett et al. 2007). A systems approach to ICDPs not only calls for consideration of economic, environment, socio-cultural, and political contexts but also participation of all stakeholders. In this project of wild honey hunting in Aborlan, NGO interventions focused mostly on the hunter and gatherers and overlooked the non-honey hunters who also have a stake in the community's resources. Moreover, a systems approach should also result in increased interactions between theory and practice. Quite a number of studies on systems approach to natural resource management exist (e.g. Bellamy et al. 2001; Rammel et al. 2007; Tàbara and Pahl-Wostl 2007), and to ensure their implementation in practice, there is a need for knowledge brokers who can decipher sound science and consequently lobby for their application on the ground.

5.6 Conclusion

Indigenous wild honey hunting and gathering as an ICDP shows the complexity of the social-ecological system of forest communities. It also shows the difficulty of getting a win-win situation out of simultaneous pursuit of forest conservation and rural development. As shown by NDVI values from spatial analysis of community households and wild honey bee nesting tree areas, vegetation has decreased despite the promotion of NTFPs as an intervention. In addition, there is a low level of non-honey hunter local knowledge on the giant honey bee and we attribute this to decreased interaction with bees most likely brought about by a decrease in vegetation and decreased immersion time in the community because of the need to attend formal educational instruction outside of the community. Knowledge shifts can, indeed, occur from the interaction of ecological and social factors and we see that if resource management interventions do not employ a systems approach, it can overlook important feedback. NGO interventions should not only facilitate the learning of visible resource managers like wild honey hunters but of the community as a whole.

6 Economic sustainability of the value chain of the Tagbanua wild honey community forestry enteprise

6.1 Abstract

Commercialization of NTFPs has been one of the strategies in addressing rural poverty and forest degradation. This strategy has been explored on the island of Palawan in the Philippines for indigenous wild honey hunter and gatherers. With the support of a non-government organization, indigenous Tagbanua communities were able to participate in a community forestry enterprise with a system of consolidation, selling, and marketing of wild honey. This marketing opportunity transformed a socio-cultural traditional practice into an economic activity. In this chapter, we examine the role of wild honey hunting and gathering in supporting livelihoods of Tagbanuas by conducting an integrated value chain analysis, which incorporates socio-cultural analysis in order to capture the impact of transforming a traditional NTFP to a market product on indigenous culture. Using both qualitative and quantitative approaches, we show that downstream actors capture most of the economic value of wild honey and that commercialization of wild honey has negative impacts on the traditional culture of Tagbanuas. The majority of the community members still use honey, but in low amounts. We conclude by highlighting the challenges of commercializing indigenous NTFPs as a livelihood strategy and providing recommendations for sustainable enterprise development in wild honey communities.

6.2 Introduction

Conservation success typically has a higher probability in areas without human activity compared to areas that also aim for community development and participation (Wilshusen et al. 2002). This has led to a dilemma, which often pits conservation against development of rural communities. Alternative concepts, however, postulate that conservation efforts may be successful even in the presence of human occupants (Carter et al. 2012). This paradigm is demonstrated by the promotion of NTFPs as opportunities to achieve improvement in livelihoods and forest conservation. First introduced by de Beer and McDermott (1989) and promoted by the research of Peters et al. (1989) in Brazil, NTFPs have been subjected to close scrutiny in the past couple of years similar to the debate around land sharing and land sparing (Fischer et al. 2008; von Wehrden et al. 2014). The proponents of the NTFP concept see it as a middle ground between polarized conservation and human development advocates, with the "conservation by commercialization" strategy seen to address both ecological and social concerns (Arnold and Perez 2001). Critics, on the other hand, point to the negative impacts of international markets on forest people as well as scalability of assessments (Sheil and Wunder 2002; Sills et al. 2011). Nevertheless, NTFPs are still seen as important in rural livelihoods in developing countries (Shackleton et al. 2015). Approximately 80 percent of populations of developing countries use NTFPs for health and nutritional needs (FAO 2014a). Studies about NTFPs have steadily increased over the past two decades but research gaps remain. Shanley et al. (2015) expounded on basic field research gaps on the ecology, use, and management of NTFPs as well as information and implementation gaps on inventories and production studies, complex management systems, policies, trade and cultural importance.

In this chapter, we aim to understand the risks and opportunities of NTFPs in supporting rural livelihoods, particularly of indigenous peoples. Indigenous peoples usually depend on a broad variety of forest products for their own consumption and for external trade (Belcher and Kusters 2004; Newton et al. 2016). In addition, cultural values influence the use of forest products among indigenous people who have a connection to forested areas (Cocks 2006; Sills et al. 2011). Some indigenous NTFPs have found their way to commercial markets, in the process transforming from a traditional product to a commercial commodity. The impact of commercialization on the socio-cultural practice of NTFP gathering has yet to be mainstreamed in NTFP research. Our study addresses this gap by quantifying the transformation of indigenous NTFPs through a value chain analysis of a case of an indigenous Tagbanua community in the province of Aborlan on Palawan island in the Philippines. The Tagbanua community includes traditional hunter-gatherers of wild honey from the giant honey bee. This area has also been studied by Nygren et al. in 2006; however, their analysis focused only on factors affecting NTFP gathering and not the consequences of such practice. By looking at the production-to-consumption system of indigenous wild honey, we not only contribute to filling NTFP research gaps but also to refining the way value chain analysis is conducted through integrating indigenous cultural components.

According to Bolwig et al. (2008) most value chain studies have only focused on how poor people's participation in value chains affects their income opportunities, largely overlooking whether it also exposes poor people to risks. In order to provide a balanced study of the risks and opportunities associated with an indigenous NTFP enterprise, we have three objectives in this chapter. Our first objective (1) is mapping the value chain of wild honey by identifying the actors and the core processes and value addition they facilitate in transforming raw honeycombs to market products such as honey and beeswax. Our second objective (2) is analyzing the costs and margins of wild honey and beeswax sales throughout the numerous channels until it is bought by an end-user. Our third objective (3) is characterizing the environmental, socio-cultural, and institutional context, which influences the livelihoods of indigenous wild honey gatherers.

The rest of this chapter is structured as follows: subchapter 6.3 provides our conceptual framework (subchapter 6.3.1) for an integrated value chain analysis and outlines the methodological approaches (subchapter 6.3.2) we used in answering our three objectives; subchapter 6.4 enumerates our results; and subchapter 6.5 provides our discussion. We conclude this chapter in subchapter 6.6 by highlighting challenges of commercializing indigenous NTFPs as a livelihood strategy and providing recommendations for inclusive enterprise development in wild honey communities.

6.3 Methodology

6.3.1 Conceptual framework

In this chapter, we introduce a conceptual framework (Figure 6.1) for an integrated value chain analysis of indigenous NTFPs. We combined elements from Belcher's (1998) production-to-consumption systems (PCS) approach with Bolwig et al.'s

(2008) strategic value chain framework, Trienekens' (2011) framework for developing country value chain analysis, and Jordaan et al.'s (2014) smallholder farmer value chain framework. Combining the elements of these different frameworks enable a holistic analysis of rural enterprises, but unfortunately does not capture the socio-cultural nature of indigenous NTFPs. We, therefore, added the element of culture in order to trace the impact of transforming an indigenous NTFP to a market product.

Our conceptual framework explores the connections between value chain context, value chain supporters, and value chain actors. Institutional arrangements, resource base, and infrastructure – comprising the value chain context – influence the whole value chain in the transformation of an indigenous NTFP to a market product.

Value chain actors carry out core processes, which transform the indigenous NTFP to a market product. Upstream actors hardly reached by government services are mostly supported by non-government organizations while downstream actors easily access government support. Horizontal relationships mostly occur among downstream actors and governed mostly by socio-cultural norms and informal agreements. The interaction between downstream and upstream actors is a vertical relationship mostly governed by formal constraints. Each actor may also add an enhancement (also known as value addition) to the product as it moves horizontally or vertically along the value chain.

Value chain supporters may facilitate value addition through provision of information, training, or research and development. We operationalized this conceptual framework through the multi-step methodology of value chain mapping, gross margin analysis, and contextual analysis.

6.3.2 Data collection and analysis

Data for this chapter was gathered between June 2014 and December 2015 in Aborlan and Puerto Princesa in Palawan (Palawan's provincial capital) and Quezon City in Metro Manila (the capital of the Philippines). Prior to data collection, the sending research institute provided ethical clearance and the receiving local community gave a research permit. Qualitative and quantitative empirical approaches were employed during the fieldwork.

Through key informant interviews and participant observation in the Tagbanua community in Sagpangan, Aborlan, NATRIPAL, NTFP-EP Asia, and SAKTAS and retailers in Puerto Princesa and Metro Manila, we mapped the wild honey value chain by identifying its network structure, which is comprised of upstream and downstream actors with horizontal and vertical relationships. We also identified the core processes, which transform the wild honeycombs into marketable products along with the value added to the product by each core process and actor. This method addresses objective one by making use of three elements in our conceptual framework (Figure 6.1), namely upstream and downstream actors, core processes, and value addition. The intermediary NGO gave us access to the wild honeycomb harvest and sales record of the wild honey enterprise for the year 2015.

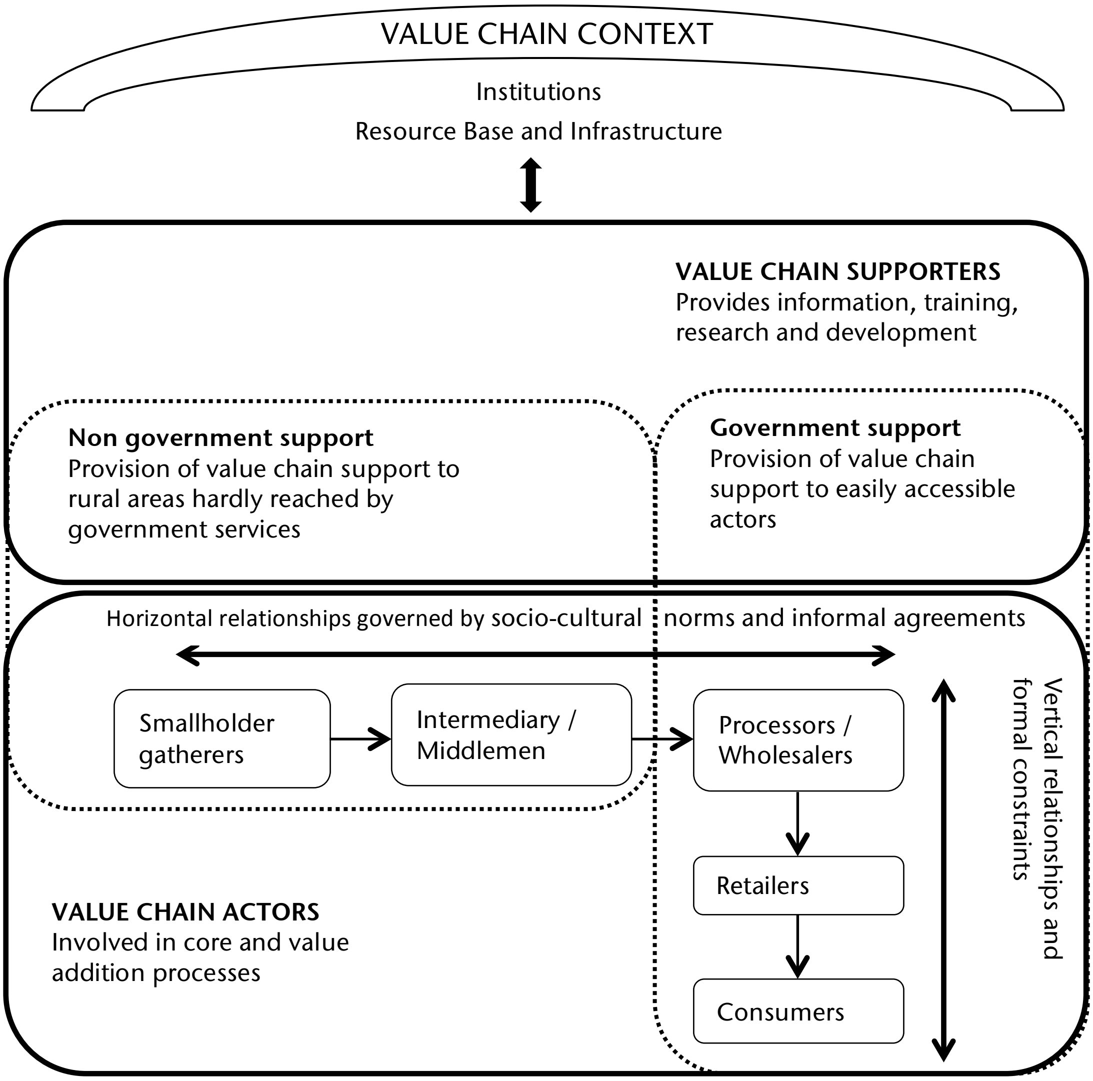

Figure 6.1 Conceptual framework of an integrated analysis of indigenous NTFP value chains. The analysis focuses on value chain context, value chain actors, and value chain supporters. The value chain context comprises institutions and resource base and infrastructure. The value chain actors are grouped into upstream (source of honey) and downstream (consumers of honey) actors. The value chain supporters consist of NGO and government support.

Through key informant interviews with the different value chain actors, we identified the costs associated with each value addition thereby obtaining the farm gate (the price at which honeycomb is sold by the indigenous honey hunter and gatherers), factory gate (the price at which processed honey or beeswax is sold by the processing organization), and free on board (FOB) (the price quotation given to retailers, including transportation costs from the processing organization up to the shipping vessel) prices of wild honey in each value addition step. With this information, we calculated the gross margin (GM), which is defined as:

$$GM = Total\ Revenue\ (TR) - \ Total\ Variable\ Cost\ (TVC) \qquad (6.1)$$

TR is the total revenue or sales from wild honeycomb or its products. The total variable cost (TVC) represents the expenses associated with gathering or processing the wild honeycombs. Gross margin analysis only includes variable costs, which are directly associated with the creation of goods and services and have been seen by academic accountants and economists as the most relevant for product decisions (Robin and Kaplan 1988; Boyte-White 2014). This analysis addresses objective two of this chapter, i.e. understanding the costs and margins of wild honey and beeswax along the value chain. For comparability of profitability, we tabulated the GM earned by each actor along with the determinants of each GM.

In order to understand the context, which influences the livelihoods of the Tagbanuas and the wild honey enterprise (i.e. the third objective of this study), the elements of culture (socio-cultural norms), environment (resource base), and governance (informal and formal constraints) in our conceptual framework (Figure 6.1) were operationalized through qualitative analysis. Key informant interviews and oral histories were conducted with 20 indigenous Tagbanua honey hunters and gatherers and two consolidators in Aborlan, two supporting NGOs and two retailers, and three relevant government offices in Puerto Princesa and Metro Manila. For the key informant interviews, a questionnaire was drafted with open-ended inquiries on governance, specifically on market regulations and institutional support. We used Scott's (2014) institutional pillars in analyzing the structure of interactions among the different actors. A survey was also conducted with 251 households without honey hunter and gatherers and their current use of honey. Answers were coded low ($\leq$ 1 liter), medium ($\leq$ 2.5 liters), and high (> 2.5 liters). Descriptive and inferential statistics were done through R version 3.3.2 and Stata version 14.2. Participant observation was employed during honey gathering in the forest and honey consolidation in the community to gain information about resource base use and management and socio-cultural practices that affect the value chain and vice versa.

6.4 Results

6.4.1 Value chain map

The network structure of the value chain (Figure 6.2) of the indigenous wild honey enterprise in Sagpangan, Aborlan, Palawan is comprised of three upstream actors, i.e. honey hunters, honey gatherers, and consolidators, and three downstream actors. A honey hunter typically looks for honeycombs in the forest during the summer season (March to June). In some cases, a honey hunter may also be a honey gatherer who climbs trees to reach honeycombs, which are thereafter sold to consolidators. Sometimes the honey hunters and gatherers also sell honey squeezed from the honeycombs to individual customers. Consolidators buy the honeycombs at a fixed price per kilo and deliver these to the intermediary NGO (NATRIPAL) in Puerto Princesa. Earnings are equally divided amongst honey hunter and gatherers. NATRIPAL along with its network of retailers are the principal downstream actors. NATRIPAL processes the honeycombs by gravitational filtration to wild honey and melting beeswax in its honey processing laboratory. These are either sold in bulk to retailers or in retail quantities to customers. Retailers buy wild honey in bulk and sell it to individual customers. Most of the retailers of NATRIPAL are based outside of Palawan.

Each value chain actor, regardless of his or her position in the network structure, adds value to the product. The honey hunters and gatherers collect honeycombs in the forest through their traditional skills and knowledge. The consolidators store honeycombs for up to five days to avoid fermentation and then transport these to NATRIPAL's honey processing laboratory in Puerto Princesa, where these are processed into honey and beeswax through gravity filtration and beeswax purification. Filtered honey is either bottled for sale in NATRIPAL's shop or is shipped in big containers to retailers who bottle the honey under their own label and sell it to individual customers. The beeswaxes are sold in blocks of different sizes.

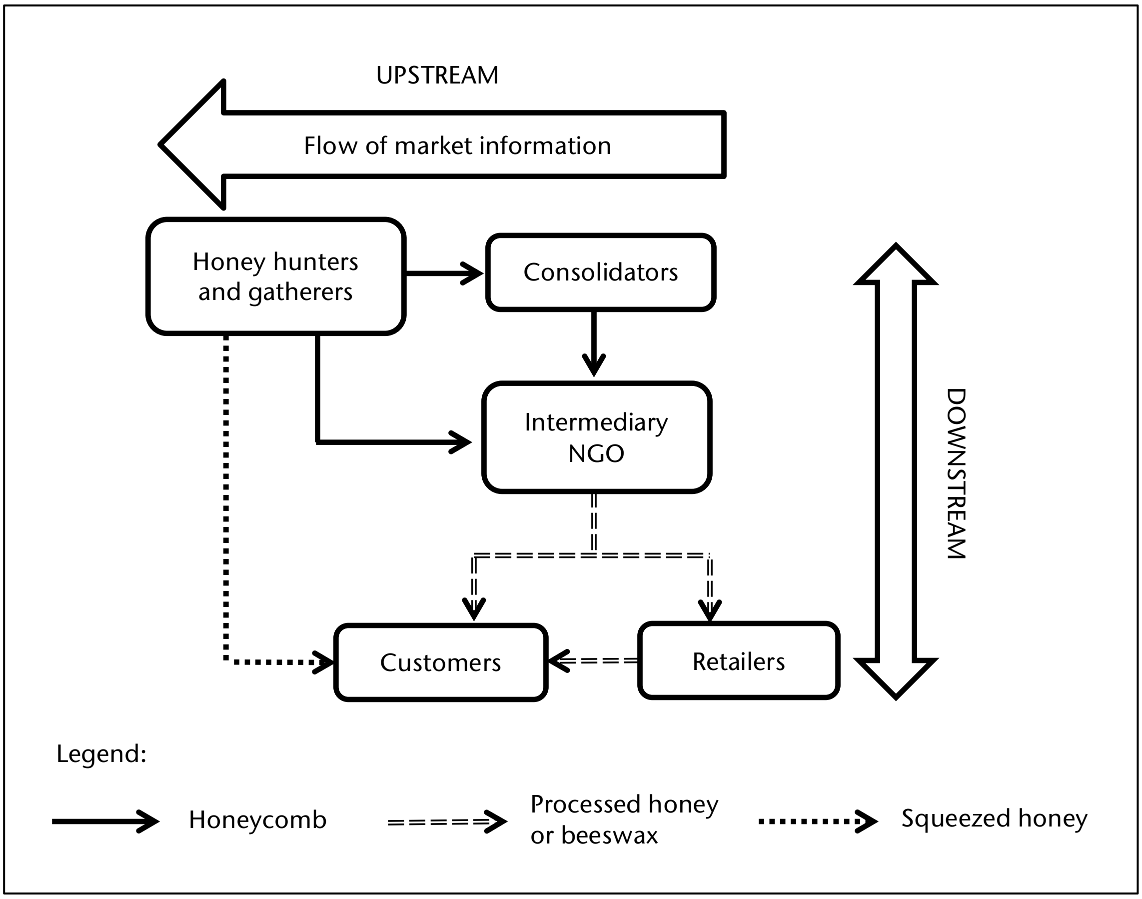

Figure 6.2 Value chain map of main actors in wild honey community forestry enterprise in Aborlan, Palawan. Upstream actors sell either honeycomb or squeezed honey. Downstream actors process the honey to sell to retailers or individual customers.

The upstream and downstream actors have clear gendered employment. The wild honey hunter and gatherers in Sagpangan, Aborlan are predominantly male. Out of 79 wild honey hunter and gatherers, only seven were female. The consolidators, on the other hand, have a balanced employment of women and men. All of the upstream actors are indigenous Tagbanuas. The NATRIPAL's permanent staff is comprised of indigenous Tagbanua and Palaw'an men and women, while the hired labor (honeycomb processors) are primarily made up of women who do not belong to any of the indigenous groups in Palawan. The retailers consist of a mixture of male and female proprietors.

6.4.2 Gross margins

The annual GMs for wild honey in 2015 considerably increased from the upstream actors to the downstream actors (Table 6.1). The honey hunter and gatherers earned the least among all actors in terms of price per kilo with an average gross profit of 30.74 Philippine Peso (Php). For the consolidators, gross profit averaged at 30.66 Php while the intermediary NGO earned 184.12 Php per kilo of honeycomb. The gross profit of retailers is the highest at an average of 585.00 Php per kilo of honey.

The amount of honey that NATRIPAL buys depends on their available capital. During the year 2015, NATRIPAL did not have enough capital to buy honeycombs sold by the honey hunters and gatherers. This prompted the implementation of a quota system on the amount of honeycombs each indigenous community could sell to NATRIPAL. Despite being able and willing to find more honeycombs, the honey hunters and gatherers in Sagpangan stopped gathering honeycombs for the season. Almost 11,000 kilos of honey were bought from all of the indigenous communities in Palawan, including the 1,500 kilos from Sagpangan. This was enough to meet the demand of retailers in 2015.

Table 6.1 Annual gross margins of wild honey actors during the year 2015. All actors profit from the sale of honey from giant honey bees after all (physical) variable costs have been accounted for. The downstream actors have the biggest profit margin among all value chain actors.

	Hunter gatherer	Honey consolidator	Intermediary NGO	Retailer
Average quantity (in kilos)	61.52 of honeycombs / year	971.96 of honeycombs / year (958.86 class A and 13.1 class B)	4,859.80 of honeycombs / year (139 beeswax and 4721 of honey)	200 of processed honey / year
Unit price of honeycomb or honey* (in Php)	60 per kilo (regardless of honey quality)	100 per kilo (class A) 80 per kilo (class B)	291.33 per kilo of honey (average)** 300 per kilo of beeswax	900 per kilo
Revenue* (in Php)	3,690.99	97,196 (class A) + 1,048 (class B) = 98,244	1,375,368.93 (honey) + 41,700 (beeswax) = 1,417,068.93	180,000
Variable costs* (in Php)				
a) Food costs while camping in the forest	75 / day or 1,800 / year	N/A	N/A	N/A
b) Transport costs	N/A	2.08 / kilo or 10,124.58 / year	N/A	(Fixed cost)
c) Purchasing of honeycombs	N/A	58,317.60 / year	479,430 (class A) / year 5,240 (class B) / year	44,000 / year
d) Community share from revenue (1%)	N/A	N/A	4,846.70 / year	N/A
e) Hired labor	N/A	N/A	250 / day or 12,750 / year	(Fixed cost)
f) Containers	N/A	N/A	4 / kilo or 19,439.20 / year	217.5 / kilo or 43,500 / year
g) Utility costs	N/A	N/A	563.33 / year	(Fixed cost)
Total costs* (in Php)	1,800	68,442.18	522,269.23	63,000
Gross margin* (in Php)	1,890.99	29,801.82	894,799.70	117,000
Gross margin per kilo* (in Php)	30.74 / kilo	30.66 / kilo	184.12 / kilo	585.00 / kilo

*Conversion rate: Php 50 = € 1 (May 2015)

**Due to lack of information on the percentage of honey sold at bottle or full and half gallon or wholesale prices, the average unit price was used.

6.4.3 Livelihood context

The role of institutions in the development of the wild honey enterprise

The power relations among the value chain actors varied as shown by the bargaining power of each actor, which increases from upstream to downstream. Upstream actors such as the honey hunters and gatherers sell their honeycombs at a price set by the intermediary NGO. The intermediary NGO also sets the factory and FOB prices of honey and beeswax, which tracks the prices of competitor honeys (e.g. cultured honey from the European honey bee or squeezed wild honey sold in the markets). Retailers set the retail price as they deem fit for their markets.

Looking closely at the overall institutional landscape through the regulative, normative, and cultural-cognitive institutional pillars (Scott 2014), we see that the whole indigenous wild honey enterprise has yet to benefit from an inclusive institution (see Table 6.2).

Table 6.2 Institutional pillars of the Tagbanua wild honey enterprise. The regulative pillar operates through rules of legal systems; the normative pillar dictates product marketing and development trends; and the cultural-cognitive pillar assigns the social positioning of value chain actors.

Regulative Pillar	Normative Pillar	Cultural-Cognitive Pillar
Food and Drug Administration (FDA) of the Philippines	National Apiculture Research, Training and Development Institute (NARTDI), Philippine National Standard on Organic Agriculture	Indigenous peoples as a distinct group (marginalized) compared to non-indigenous peoples

The Food and Drug Administration (FDA) of the Philippines is the regulative pillar in charge of giving permits to sell wild honey in mainstream markets. It requires strict infrastructural investments (e.g. use of only stainless steel containers, processing laboratory) that the intermediary NGO and the upstream actors cannot fulfill due to costs. The National Apiculture Research, Training and Development Institute (NARTDI), created under the law Republic Act No. 9151, facilitated a normative pillar that mostly focuses on beekeeping and apiculture and not on wild honey hunting and gathering. The Bureau of Agriculture and Fisheries Standards (BAFS) of the Philippine Department of Agriculture (DA) in its draft of the Philippine National Standard on Organic Agriculture lumped the giant honey bee under beekeeping, overlooking the fact that the giant honey bee in the Philippines cannot be domesticated or managed (even on a rafter) since it is an open-nesting species. Cultural-cognitive pillars have also restricted the upstream actors from moving up the value chain. One of the supporting NGOs expressed reluctance in constructing a honey processing facility in the community due to concerns on local capacity and capability while another relayed that non-indigenous peoples often perceive food products of indigenous peoples as unhygienic.

The role of traditional Tagbanua culture in the wild honey enterprise

The relationship of the Tagbanuas with wild honey bees has been chronicled since the Spanish era, starting with Manuel Hugo Venturello who published a manuscript on the manners and customs of the Tagbanuas in 1907. Wild honey bees are deeply embedded into the Tagbanua traditional belief system. Portions of the *lambay* ceremony – annually held in April or May after the rice has been planted – are concerned wholly with the appearance of bees (Fox 1982; Venturello 1907). Tagbanua hunters search continually from January until July for hives, which yield honey and edible young bees, as well as ritually important wax (Fox 1982). Dressler (2005), in addition, notes a mutually beneficial relationship between Tagbanua swidden cultivation and honey production: bees feed on rice pollen from swidden fields, while the Tagbanuas harvest rice from bee-pollinated swidden fields and collect honey from nearby forests.

The establishment of the wild honey enterprise in 1990 transformed local traditional practice of honey gathering into a distinct economic activity. Prior to the establishment of the wild honey enterprise, the Tagbanuas only gathered small numbers of honeycombs for personal consumption. Participant observation revealed two different use perspectives of the Tagbanuas regarding wild honey bees: some respondents stated that they should gather as much honey as they can because it is a gift to them by nature while some stressed that they should leave some honey for the wild bees because the wild bees worked hard for it. The importance accorded to beeswax in the earlier times seemed to have disappeared as wild honey hunters and gatherers sell whole honeycombs containing both honey and beeswax to the intermediary NGO. Of the 251 respondents interviewed in the community, despite a majority (94%) still using honey, most of the respondents (86%) use very little (less than a liter) to no honey at all. χ^2 and Fisher's exact tests were conducted to see whether use of honey is influenced by factors such as ethnicity (p = 0.372), marital status (p = 0.337), role in household (p = 0.923), or level of formal education (p = 0.660). The results were all not significant, showing that the use of honey is independent from cultural (ethnicity) and other demographic factors. In addition, participant observation showed that wild honey hunters and gatherers rarely perform rituals traditionally practiced for honey gathering.

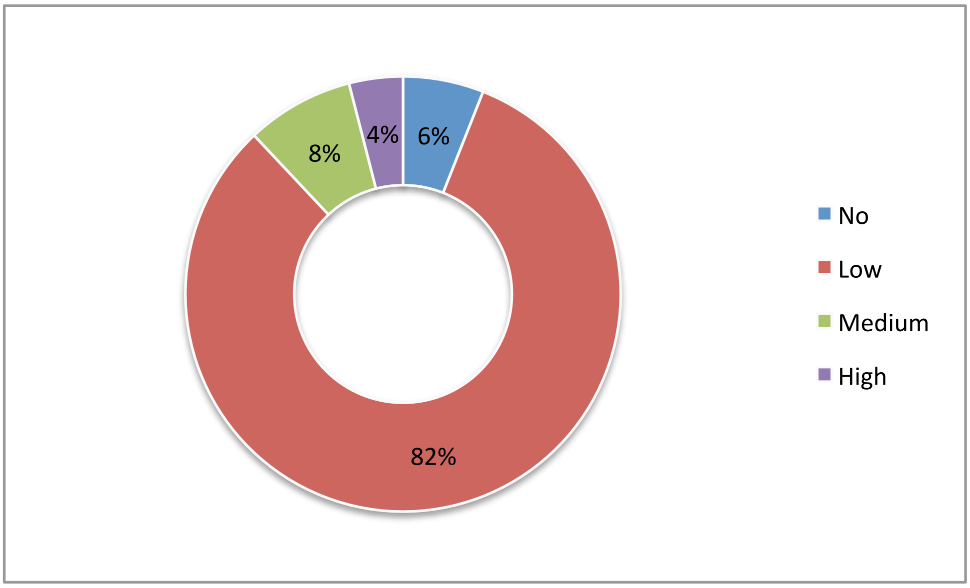

Figure 6.3 Use of wild honey by respondents from the community. The majority of non-hunter-gatherer respondents use honey in low (< 1 liter) amounts. Medium use of honey is < 2.5 liters, and high use of honey is > 2.5 liters.

The natural resource base of the wild honey enterprise

The natural resource base of wild honey products is the community forest within the ancestral domain of the Tagbanuas. Giant honey bee colonies in Palawan do not congregate on one tree, unlike that of the subspecies *A. dorsata breviligula* Maa found in the rest of the Philippines. Wild honey hunters and gatherers in Palawan can, therefore, find only one honeycomb per tree. According to oral histories conducted with older honey hunter and gatherers, it was easier to find honeycombs at the foot of the mountain forest prior to the establishment of palm oil plantations in the area. Nowadays, honey hunters and gatherers need to hike up the mountain forest and camp in the area for three to four days in search of honeycombs. The number of honeycombs per year depends on the flowering of nectar sources and its phenology. Oral histories also point to changing weather patterns as causing changes in the phenology as well as physically damaging nectar sources.

A harvesting protocol, on the basis of sustainability, asks wild honey hunter and gatherers to only harvest honeycombs and leave the brood part of the beehive. However, participant observation showed that the honey hunter and gatherers only follow this as a business strategy. After two weeks of leaving the brood, the honeycomb will be full of honey again and they will gather this for another round of selling. During one instance, the honey hunter and gatherers harvested the whole honeycomb since it was already on its second time of honey storage. They then proceeded to eat the brood, which is a common cultural practice. Direct environmental impacts of the wild honey enterprise value chain also occur at the upstream level, especially on the community forest. Participant observation revealed that non-biodegradable trash such as coffee sachets or sugar plastic bags are left behind in the forest camps. Sometimes the non-biodegradable trash is incinerated in campfire. Furthermore, there seemed to be no conscious effort to clean up as evidenced by the traces of trash in abandoned camps. In addition to forest pollution, honey hunter and gatherers hunt game such as birds for food. Participant observation during a wild honey hunting trip to the mountain forest showed that the group hunted two green imperial pigeons *Ducula aenea* L. (Columbidae). While the International Union for Conservation of Nature (IUCN) lists *D. aenea* as an animal of least concern in its Red List of Threatened Species (2016), it also points out their decreasing population trend. The same concern can be extended to the wild giant honey bees themselves, but there has yet to be a conclusive study on the impact of commercial harvesting on their population.

6.5 Discussion

Our results show that behind the rather straightforward and simple value chain of wild honey, there are complexities and challenges hindering upstream actors from fully benefiting from the enterprise. Upstream actors are restricted to low value-added forest products development, resulting to minimum profits, while downstream actors involved in high value addition captured bulk of the profits. These profits, however, do not internalize externalities such as environmental or socio-cultural impacts of wild honey harvesting. Several issues that are found crucial in community forest management are discussed in detail below.

6.5.1 Power relations, benefit sharing, and equity

The economic subsystem of the wild honey community enterprise is described as an A-system (Ssemwanga 2005; Ruben et al. 2007). This is a local low-income chain, where producers are small with traditional production systems. A-systems producers deliver a high share of production volume, but generate relatively little value economic value (Trienekens 2011). The results of our gross margin analysis show that the farm gate price of honey only increased by five pesos in the last ten years. In 2004, honey was bought from honey hunters at 55 Php per kilo and in 2015, it was at 60 Php per kilo (Nygren et al. 2006). In addition, gross margin analysis only account for the physical variable costs. Since the hunter-gatherers do not pay themselves for their labor in hunting and harvesting honey, this has not been accounted for in the variable costs. This is a non-physical cost, which would have made the profit margin of the upstream actors less than what it is if it would have been accounted for.

Our study also shows that upstream actors can only access limited market information from the intermediary NGO, contrary to what Nygren et al. (2006) noted in their earlier study of the wild honey enterprise. With the enterprise as a monopsony and with the upstream actors' lack of access to market information, most of the bargaining power rests with the downstream actors. In a monopsony, the buyer can strongly influence the price at which transactions take place and the sellers have no choice but to comply with the buyer's specifications (Bates 2005; Trienekens 2011). Similar to the case of honey farmers in Tigray, Ethiopia, this focus on spot markets results in a patron-client relationship, which perpetuates asymmetric access to market information that further inhibits community capacity and market development (Pacheco 2012; Alemu et al. 2016).

The reluctance of value chain supporters to train upstream actors in high value addition such as honey processing and storage prevents the honey hunters from benefitting from seasonal price changes since they do not have the means to store honey. Similar to matsutake mushroom farmers in China, the honey hunters cannot afford to hold on to the honeycombs until the price is right (He 2010). If honey hunting remains as a subsistence strategy, its primary objective will always be provision of household needs rather than profit maximization (Anderson 2003).

Our results, therefore, point to the wild honey enterprise as failing in the three elements of equity proposed by Brown and Corbera (2003), which are equity in access, decision-making, and outcome. Persistent failure in equity leads to a failure in poverty alleviation, which could result to increased pressure on forest resources (Sunam and McCarthy 2010). If this occurs, neither livelihood nor forest conservation would be attained.

6.5.2 Forest conservation, traditional livelihood, and indigenous culture

The traditional practice of honey hunting and gathering by indigenous Tagbanuas served as both subsistence livelihood strategy and cultural heritage. Similar to the Ogiek people of the Mau Forest in Kenya and many other hunter-gatherers worldwide, the transmission of hunting and gathering through generations was achieved through inter-generational apprenticeship and experiential learning (Ronoh et al. 2016). It has also largely stuck with traditional gender roles, men being the primary harvesters of forest products procured deep in the forest or requiring physical hard labor (Shackleton et al. 2011b).

Without the introduction of modern technologies or market involvement, we expect traditional subsistence strategies to persist and – barring higher population density – forest regeneration to continue. However, in the opposite scenario of increased population pressure or resource exploitation for markets, resource stewardship becomes a must (Holt 2005). It highlights the issue of power in social-ecological interactions, where hunter-gatherers have used fire as a tool to domesticate wild honey bees (Gouldsblom 2015; Boonstra 2016). It, therefore, raises the question whether NTFP commercialization defeats its purpose of forest conservation. It is a blessing in disguise that the intermediary NGO experienced financial constraints that hinder it from purchasing all honey on offer; it unintentionally controlled honey hunting because the honey hunters stopped gathering honeycombs in the absence of buyers. This is contrary to conservation by Payment for Ecosystem Services (PES), where lack of finance can result in lack of conservation (Wunder and Wertz-Kanounnikoff 2009).

Commercializing traditional livelihoods can be a double-edged sword: it can bring material benefits but may not always impact culture beneficially (Anderson 2001). Similar to the Kurumba honey hunters in India, the Tagbanuas no longer, if not rarely, conduct prayer ceremonies prior to hunting (Keystone 1994; Anderson 2000; Anderson 2001). There is an opportunity cost associated with observing these rituals in a market activity that depends on efficiency (Brosi et al. 2007). Cash income may affect indigenous culture in different ways: either abandoning culture to seize new income opportunities or changing cultural practices because of influx of money. The former is exemplified by the case of the Tagbanuas, who resorted to selling culturally important products such as beeswax and intensifying harvest of honeycombs to earn more income. The latter can be seen in the case of indigenous Cuyabenos in Ecuador, who adopted external languages and habits when income suddenly increased (Wunder 2000).

6.5.3 Alternative development pathways

Rural livelihoods are often heavily reliant on a natural resource base as is the case with Tagbanua honey hunters (Scoones 1998). Sustainable livelihoods for the Tagbanuas would, therefore, need a flourishing natural resource base that is able to provide goods when needed. However, we see that there is a danger of overexploitation if the market pathway continues to be treaded without any regulations (Figure 6.4). Hunting provides benefits, but the utilization of the benefits as either commercial commodity or personal goods can determine the intensity of hunting wild honey bees in the forest, which can lead to either potential degradation (high intensity of hunting, bold line) or continued regeneration (low to medium intensity) of forests.

As suggested by Oldroyd and Wongsiri (2006), immediate regulations should be put in place to control hunting of the giant honey bee until surveys are conducted to determine wild bee population densities and reproduction rates. The traditional pathway, within the context of minimal population pressure and non-market exploitation, could become the blueprint for controlled and upgraded “modern” wild honey bee hunting that could serve as a niche market system. The factory gate price of wild honey is below its potential market value due to its dependence on the price of cultured honey, externalization of occupational risks and labor costs, and non-recognition of distinct wild honey attributes (e.g. organic product). These are market failures that can potentially be corrected by wild honey niche market development through improved product information that could ultimately be reflected in price premium for honey (Gracia and de Magistris 2007; Roitner-Schobesberger et al. 2008; Singh et al. 2010; Hempel and Hamm 2016; Pallante et al. 2016). Similar to the case of NTFP finger millet landraces in Nepal, the current farm gate and factory gate prices of wild honey are not up to par with the price premium that urban consumers are paying retailers (Pallante et al. 2016). In combination with harvesting regulations, the price premium of a niche market, instead of focusing on quantity, could provide wild honey hunters with the same amount of income but for fewer and higher quality honeycombs.

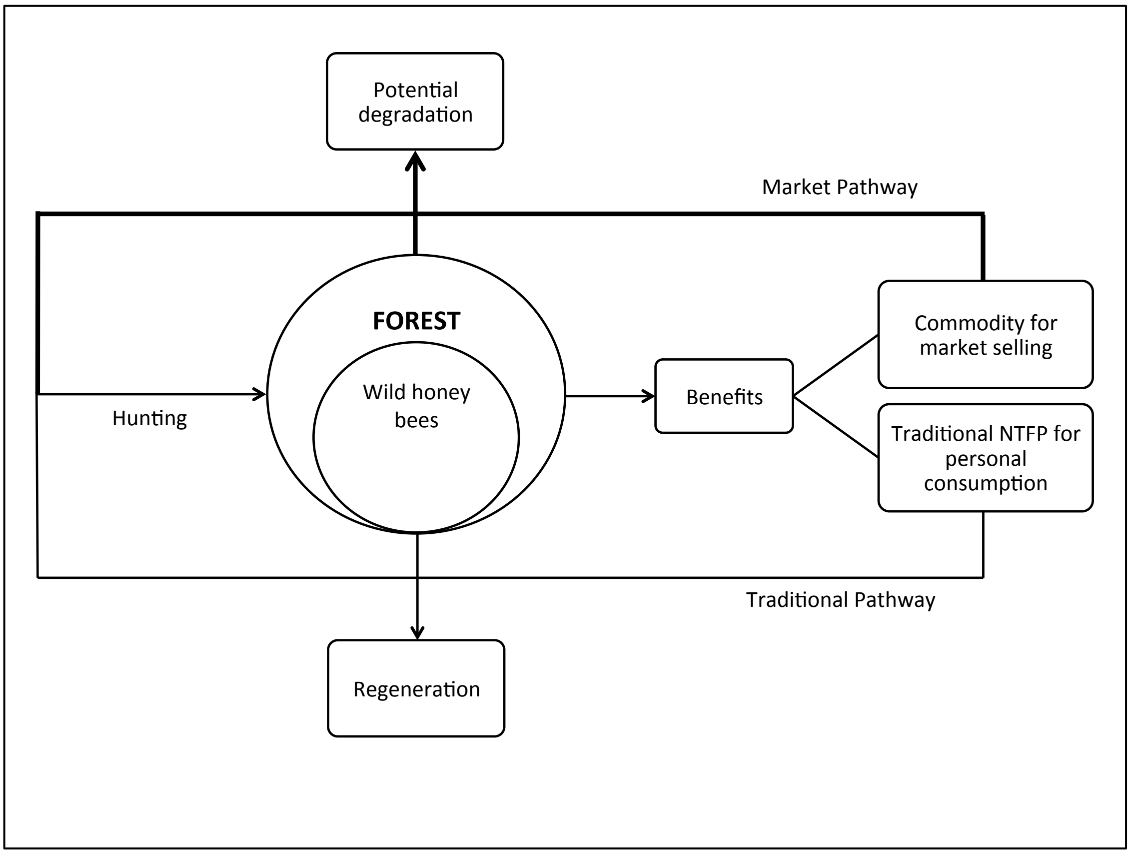

Figure 6.4 Alternative pathways of wild honey hunting. The market pathway has a potential for intense hunting compared to the traditional pathway.

6.6 Conclusion

Conducting an integrated value chain analysis of the indigenous wild honey enterprise of the Tagbanuas in Sagpangan, Aborlan, Palawan showed that commercializing the traditional NTFP has more disadvantages than opportunities for the upstream actors. The value chain map (Figure 6.2) of the wild honey enterprise showed that most of the value added to the wild honeycombs happened at the downstream level. The upstream actors are mostly confined to providing wild honeycombs as raw materials. Analysis of the gross margins of each actor (Table 6.1) showed that retailers gained the highest profit while the wild honey hunters and gatherers earned the least amount of profit. As a monopsony, the enterprise only had the intermediary NGO as its lone dependable buyer of honeycombs. As a consequence, the bargaining power of the wild honey hunters and gatherers is rather weak. Outside of the enterprise, there is no strong institutional support for the wild honey enterprise. The Philippine government mostly focuses on beekeeping and apiculture and requires the wild honey enterprise to invest in costly infrastructure before the enterprise can get a Certificate of Product Registration. Social discrimination against the Tagbanuas and other indigenous peoples hinders them from moving up the value chain. Traditionally, Tagbanuas gather wild honeycombs for household consumption and for the ritually important beeswax. With the advent of the wild honey enterprise, the Tagbanuas started gathering as many honeycombs as possible from the forest and only retained very small quantities for their own consumption. They also rarely store beeswax and rituals are no longer performed regularly. Tagbanuas have also minimized their traditional practice of eating brood in order to comply with the sustainable harvesting protocol, which also allows them to collect a second round of honey from the beehives after the initial harvested the honeycomb has been replaced by the colony. This increase in honey harvesting activities directly impacts the forest environment through pollution and increased wildlife hunting by the hunter-gatherers. Research should be conducted to determine the maximum sustainable yield of the giant honey bee and results should be able to define thresholds of ecologically sustainable harvesting practices. Economic modeling of occupational risk of wild honey hunters should also be conducted as this can enable a more accurate pricing of wild honeycombs. Lastly, we recommend the further application of an integrated value chain analysis in traditional NTFPs to assess the opportunities and risks associated with commercializing NTFPs.

7 Thinking out of the "Langstroth" box: towards increased conservation of honey bee diversity

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7.1 Abstract

A decline of wild pollinators, along with a decline of bee diversity, has been a cause of concern among academics and governmental organizations. According to the IPBES, a lack of wild pollinator data contributes to difficulties in comprehensively analyzing the regional status of wild pollinators in Africa, Latin America, Asia and Oceania. It may have also contributed to the prevailing lack of awareness of the diversity of honey bees, of which the managed European honey bee is often considered as "the (only) honey bee," despite the fact that there are eight other honey bee species extant in Asia. A survey of 100 journal articles published in 2016 shows that 57% of the studies still identified the European honey bee as "the honey bee." In total, 80% of studies were conducted solely on the European honey bee. This focus on the European honey bee has also caused the honey standard of Codex Alimentarius and the European Union to be based solely on European honey bee, causing improper evaluation of honeys from other species. We recommend adapting current standards to reflect the diversity of honey bees and in the process correct failures in the honey market and pave the way towards improved protection of honey bee species and their habitats.

7.2 Introduction

The decline of wild pollinators, coupled with the decline of bee diversity, urgently requires long-term international and national monitoring of both pollinators and pollination (IPBES 2016b; Potts et al. 2016). This urgency has not been lost on the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD), which included the thematic assessment on pollinators, pollination and food production of IPBES as an agenda item in its 13th meeting. A lack of wild pollinator data such as species identity, distribution, and abundance has hindered an analysis of their regional status in Africa, Latin America, Asia and Oceania and may have also contributed to the prevailing lack of awareness of wild honey bees (IPBES 2016b). The European honey bee, managed in Langstroth boxes and also commonly called the managed or Western honey bee, has been put under the spotlight due to high seasonal losses of colonies mostly in countries belonging to the Northern Hemisphere; the widespread presence of European honey bee and the intensive study it has been accorded to facilitated the observation of this phenomenon (Oldroyd and Wongsiri 2006; Koeniger et al. 2010; Neumann and Carreck 2010; Potts et al. 2010; Potts et al. 2016). It is, therefore, not surprising that the European honey bee is often cited as "the honey bee," despite the fact that there are eight other honey bee species. This has led to the inconsistent use of the term "honey bee" in publications; for e.g. in the study by McLoone et al. (2016), the European honey bee is called "honey bee" but the giant honey bee is simply referred to as "bee". The study by Garibaldi et al. (2013) compared pollination efficiency of wild insect pollinators to "managed pollinators such as honey bees," overlooking the detail that most honey bees (giant honey bee, black dwarf honey bee, Himalayan honey bee [*A. laboriosa* S.], montane honey bee [*A. nuluensis* Tingek, Koeniger, and Koeniger], red honey bee [*A. koschevnikovi* Buttel-Reepen or Enderlein], Philippine honey bee [*A. nigrocincta* S.], dwarf honey bee [*A. florea* Fab.]) cannot be managed and are classified as wild (Koeniger et al. 2010).

In this chapter, we set out to emphasize the diversity of honey bee species and the ecological and socio-economic implications of the longstanding unfamiliarity with the lesser known honey bee species. We briefly take a look at the ecological and social contributions of honey bees to forests in Asia, which is the endemic habitat of all honey bee species (hereinafter referred to Asian honey bees) other than the European honey bee. A study by Wallberg et al. (2014) showed that the origin of the European honey bee is closer to Asia than Africa, which further boosts arguments for increasing research focus on Asian honey bees. Currently, Asia is outside the immediate geographical interest of international efforts such as the International Pollinators Initiative (IPI) and the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTA) of the CBD (see CBD 2016). We conclude this chapter by making recommendations on how to better recognize and appreciate the diversity of honey bees and their socio-ecological contributions by improving existing regulations on honey bees, which can pave the way to the correction of market failures and inconsistencies in academic research.

7.3 Reputation of the European honey bee as the only honey bee

We conducted a search crawl on Google Scholar of scientific journal articles containing the search term "honey bee" published in 2016. Patents, citations, and books were excluded from the inquiry as well as journal articles from the computer science field discussing the honey bee colony as basis for algorithms. We examined 100 journal articles (see Appendix III for complete list) we had institutional access to and searched for the terms "honey bee", "honeybee", "*Apis*", and "*A.*" (an abbreviation of the genus *Apis*) to understand if authors qualified these terms with corresponding honey bee species and associated the terms with the proper common names. Out of the 100 articles surveyed, the majority (57%) solely called the European honey bee as "the honey bee" or plainly used the term "honey bee" (sometimes spelled as honeybee) without identifying the species. Eighty percent of the articles conducted research solely on the European honey bee; the rest of the studies either covered the European honey bee in combination with other honey bee species (10%) or on other honey bee species such as the Eastern honey bee, the giant honey bee, or dwarf honey bee.

Opportunities for protecting Asian honey bees are so far lacking, which is in stark contrast to the European honey bee. An example is the coalition of the willing founded by the Netherlands with other European countries during the 13th meeting of the CBD COP to take national action to protect pollinators in the interest of food security (UN News Centre 2016). This is a welcome initiative, but since it is country-led, protection would only extend up to the national borders of the coalition members. When it comes to protecting honey bees as pollinators, only the European honey bee may be protected because the eight other honey bee species cannot be found in Europe. Protecting Asian honey bees does not only contribute to biodiversity conservation, but also to supporting traditional livelihoods dependent on ecosystem services from the honey bees such as in Vietnam, India, Indonesia, Philippines, and Thailand (Fox 1982; Crane et al. 1993; Chinh 1995; Mahindre 2000; Tan 2006).

7.4 Asian honey bees and their contributions to forest communities

Asian honey bees similarly provide the often-cited ecosystem services from the European honey bee. Apart from being prey to some endemic vertebrates, Asian honey bees are key pollinators not only of agricultural crops but also of Dipterocarp trees known for its excellent timber quality mostly found in Southeast Asian forests (Itioka et al. 2001; Oldroyd and Nanork 2009). Asian honey bees also provide forest communities with food in the form of brood and bee products such as honey and beeswax, which has been identified as culturally important to indigenous communities such as the Tagbanuas in the Philippines (Fox 1982).

Hunting of honey bees has been traced as far back as the Pliocene epoch and is still prevalent today especially in South and Southeast Asia, where indigenous honey hunters and gatherers traditionally hunt the giant honey bees and the Himalayan honey bee, which can yield 20 liters or more of honey per harvest (Crane et al. 1993; Crane 1999). NGOs such as NTFP-EP in Asia, which are keen to implement ICDPs, saw the potential of honey hunting and gathering as a community forestry enterprise. With international platforms such as Apimondia or Asian Apicultural Association prioritizing apiculture of the European honey bee, NTFP-EP Asia facilitated the founding of the Asian Forest Honey network that focuses on honey hunting and gathering of Asian honey bee species. This was launched in 2015, along with the Forest Harvest collective mark, in a quadrennial conference called *Madhu Duniya*, which brings together honey harvesters from Cambodia, India, Indonesia, Malaysia, the Philippines, and Vietnam to discuss issues pertinent to Asian honey bees. This is an important step in pushing for better recognition of forest honey, i.e. honey from indigenous Asian honey bee species, because the existing universal honey standard Codex Alimentarius and quality criteria are based on honeys of the European honey bee, which make measuring the quality of honey from the giant honey bee or the Himalayan honey bee using the yardstick of the European honey bee akin to expecting a "duck to lay a chicken egg" (Koeniger et al. 2010; WHO and FAO 2016).

7.5 Codex Alimentarius implications for conservation and sustainable development

NTFP-EP (2015) sees honey hunting and gathering as having the potential to protect seven million hectares of community forests through bee habitat conservation. Annual production capacity of forest honey in South and Southeast Asia is pegged at 2000 tons, with the potential to contribute 13 million USD to the Asian economy, not including possible contributions to Europe and other continents (NTFP-EP 2015). But with Codex Alimentarius tailored for honey from the European honey bee, honeys from the giant honey bee, the Himalayan honey bee, and the Eastern honey bee have difficulties competing for higher value markets. Europe is a potential market, being the world's second largest producer of honey but having a domestic production that only covers 60% of the region’s consumption (EC 2016). However, in addition to the hurdle posed by Codex Alimentarius, the European Union only recognizes “the natural sweet substance produced by *Apis mellifera* bees” as honey, thereby classifying forest honey from other honey bee species as non-honey (EU Council 2002).

Due to the legal restrictions of the Codex Alimentarius and the EU Council’s Directive on Honey, there is little recognition of the diversity of honey bees. This impacts negatively on Asian honey bee species, their forest habitats, and their traditional hunters. Forest honey from indigenous Asian honey bee species is regarded as inferior to that of the European honey bee, encouraging Asian governments to focus conservation, research, and economic priorities on the introduced species rather than their native species (e.g. National Bee Board in India, National Apiculture Research, Training and Development Institute in the Philippines). As a consequence, wild honey hunters and gatherers are excluded from development opportunities and extension services, which do little to advance progress on sustainable development goals, especially on combating poverty in indigenous communities (Bradbear 2009). Unless poverty is alleviated, conservation will always be undermined (Adams et al. 2004; Garnett et al. 2007; Shanley et al. 2015). Likewise, conservation of Asian honey bees becomes a challenge if the European honey bee continues to be introduced. There is increasing evidence that viruses originally detected in the European honey bee such as deformed wing virus are widely distributed across wild honey bee species through established honey bee behavior such as robbing honey from or getting in contact with flowers visited by infected the European honey bee colonies (Koeniger et al. 2010; Tehel et al. 2016). More research is needed on pathogens of wild bee species (Tehel et al. 2016) but until this has been established, countries where Asian wild honey bees are extant would be wise to employ the precautionary principle with regard to importing and promoting beekeeping of the European honey bee.

7.6 Leveling the playing field for Asian wild honey bees

Much of honey bee species diversity originates from Asia, but most of the research has been focused on the European honey bee and conducted mostly by researchers based in the Northern Hemisphere. Closing this gap would benefit the 3Ps: people, planet, and profit. Adapting the Codex Alimentarius and the EU Honey Directive to the diversity of honey bee species may remedy the undervaluation of Asian forest honeys in the market and increase awareness for their conservation. With most of these honeys harvested in community forests with endemic tree species, their flavor and taste can be identified with territorial resource specifications, akin to wine’s terroir, and stimulate competitiveness in the honey market (Corade and Delhomme 2008; Hassen and Tremblay 2016). Consequently, this can provide forest communities with benefits proportional to the responsibility of conserving forests and provide consumers with more information on the origins of the honey they are consuming. Asian forest honey bees have yet to necessitate the chemical treatment that the European honey bee often needs to fight its parasites, and consumers can only hope that random inspections and food quality analyses ensure that honeys off-the-shelf do not contain contaminants beyond the acceptable limits.

The International Honey Commission (IHC), formed in 1990 to create a new world honey standard and thereafter provided the methods on which the Codex

Alimentarius and the EU Honey Directive were based (Bogdanov et al. 1999), can work with NGOs such as NTFP-Asia and select academic researchers who have been working on standards for Asian forest honeys. We see the potential of an integrated conservation of forests and honey bees and, therefore, recommend (1) revising Codex Alimentarius and especially the EU Honey Directive to include standards on Asian honey bees, in the process formally recognizing the diversity of honey bee species; (2) increasing market competitiveness of forest honeys through application of concepts reflecting origins such as terroir in marketing; and (3) increasing awareness on the multiple ecosystem services from Asian honey bees by funding more conservation and research efforts on them.

8 Synthesis

On a disciplinary level, findings from this research add to the body of anthropological literature on indigenous Tagbanuas, ecological work on giant honey bees and their products, economic inquiry on CFEs, and geographical analysis of community forests in Palawan. These contributions are valuable, but are not sufficient to catalyze the changes necessary for sustainability transformation when considered individually (Fischer et al. 2007; Abson et al. 2017). The more important contribution of this research is, therefore, the integrated knowledge showing the dynamics of the giant honey bee-Tagbanua system and its linkages with indigenous culture, local knowledge, and natural resource management. This has been made possible through a transdisciplinary approach, which allows for a co-production of system, target, and transformative knowledge on issues relevant for "glocal" (global and local) scales (Hirsch-Hadorn et al. 2006; Lang et al. 2012; Angelstam et al. 2013; Brandt et al. 2013).

The growing concern over the decline of bees and other pollinators has become a global issue given the substantial declines recorded in the United States and several countries in Europe (Biesmeijer et al. 2006; Goulson et al. 2008; Naug 2009; Potts et al. 2010). Unfortunately, comprehensive analysis of bees and other wild pollinator data is still lacking for many parts of Africa, Latin America, Asia and Oceania (IPBES 2016b). In addition, most of the research on bees has been conducted by the natural sciences and human-insect connections have yet to be sufficiently addressed despite the impacts of humans on bees and vice-versa (Watson and Stallins 2016; Matias et al. 2017). Through a review of the ecosystem service benefits of wild bees in social contexts, I establish system knowledge on the interlinked nature of wild bees and humans. Humans depend on wild bees for ecosystem services, but bees also depend on humans for survival given that most drivers of change in wild bee-human systems are mediated by anthropogenic activities (Matias et al. 2017).

On a local level, I have seen that giant honey bees primarily provide provisioning and cultural ecosystem services to indigenous Tagbanuas quite consistent with the results of the review conducted on a global level. Chemical analysis of honey samples from giant honey bees in the Tagbanua community forest of Sagpangan shows zero traces of chemicals regulated under the maximum residue limits for honey established by the Codex Alimentarius Commission (FAO and WHO 2016) and the Residue Limit Ordinance of Germany (*Rückstands-Höchstsmengenverordnung* or RHmV version 21.10.1999), making the honey eligible for the prime and niche market of organic products (Browne et al. 2000) and making it safer for consumption than most honey from European honey bees treated with miticides or derived from foraging in pesticide-exposed areas (Khan et al. 2004). While this may also mean that the foraging area of giant honey bees in Sagpangan, Aborlan is free from pesticides, household surveys showed that a small percentage of community members use pesticides (synthetic pyrethroids, organophosphates, and carbamates) that are known to be harmful to bees. This should be mitigated especially if the honeys are to be marketed as organic. Results of the melissopalynological analysis show at least 11 floral families contained in the honey, which point to the diversity of flora that giant honey bees appear to pollinate in Sagpangan, Aborlan. Bees forage from a broader area for pollen than nectar and seem to prefer pollen from a mixture to that of a single species (Molan

1998). Clearly, there is a need to maintain the landscape as foraging area of giant honey bees and conserve giant honey bees as pollinators of this diverse flora (Kremen et al. 2007).

Ground truth mapping coupled with spatial analysis was conducted in order to examine the habitat of giant honey bees in the community forest of Sagpangan, Aborlan. Ground truth mapping is a huge logistical and physical challenge, which cannot be accomplished by a single researcher without any experience in wild honey hunting and gathering. Seeking the assistance of the hunter-gatherers in ground truth mapping giant honey bee nests showed the advantages of a transdisciplinary approach. A participatory approach employed beyond one month, with all equipment (GPS units, digital cameras, and solar home system) left to the care and use of the community after technical training resulted in creative thinking and increased confidence in new technologies by participating community members. This approach attempted to address the blind spots of mainstream participatory methods employing new technologies; full autonomy is rarely granted to community members in using equipment, data gathering takes too much time of the participants, or target data is legitimate and credible but not salient (Cash et al. 2002; Kindon et al 2009).

The data gathered from the ground truth mapping were used to create a baseline map, where further spatial analysis was based on. Spatial analysis showed that mean NDVI values of sampled nesting tree and community household areas have dropped from the year 1988 to 2015. This is a common trend in forest communities, but in areas with ICDP interventions for more than two decades, this may be an indication that commercializing non-timber forest products is not fulfilling its objective of development alongside conservation. In addition, analysis of the linkages between the giant honey bees and the indigenous honey hunters through inferential statistics showed that a lower level of education and higher household vegetation contribute to correct identification of the giant honey bee. Only 24% of the 251 local community members surveyed, with the exception of the wild honey hunters and gatherers, could correctly identify the giant honey bee. But how much really is the livelihood gain from commercializing wild honey?

Gross margin and integrated value chain analyses incorporating socio-cultural analysis show that downstream actors capture most of the economic value of wild honey. In addition, commercialization of wild honey seems to have negative impacts on the traditional culture of Tagbanuas, with the majority (86%) of the community members surveyed use less than a liter of or no honey at all apart from abandoning traditional rituals with giant honey bees. Wild honey hunting may be contributing in avoiding further poverty, but does not seem to live up to the promise of CFEs to alleviate poverty or conserve natural resources. Minimal livelihood gains, coupled with ecological costs, could lead to a “lose-lose” situation of severe erosion of biological resources, loss of livelihoods (Uma Shaanker et al. 2004) and, rarely noticed, attrition of traditional culture. Palawan’s status as a UNESCO Man and Biosphere Reserve depends on the fulfillment of its functions, namely conservation, development, and logistic (UNESCO 2013). A decadal periodic review of Palawan’s status should be able to show that the site is living proof of sustainable development (UNESCO 2017).

On a global level, the decline of the managed European honey bee continues to elicit concern and inspire initiatives for their conservation (Watanabe 1994; Potts et al. 2010). Other honey bees, predominantly extant in Asia, unfortunately do not get a similar amount of attention. This does not only have implications for conservation, but also for development given the number of forest communities depending on the ecosystem services from the different honey bees. Markets, the academe, and institutions such as the Codex Alimentarius should adapt to the diversity of honey bees and, in the process, pave the way towards improved protection of honey bee species, their habitats, and rural development of communities dependent on these and other honey bees.

9 Outlook

This dissertation lays down the foundation for further integrated research and new modes of practice on indigenous rural development, forest protection, and wild honey bee conservation. In the following subchapters, several outstanding research questions on the defined boundaries of the SES of Tagbanuas and giant honey bees are detailed along with their potential knowledge products.

9.1 Using the transdisciplinary approach in praxis and decision-making

As global work on sustainable development through the Agenda 2030 kicks into full gear, more effort is needed to emphasize inclusivity of rural societies. In the sole SDG dedicated to forests, i.e. Goal 15, the needs as well as the significant role of forest communities in sustainable forest management seem to have been overlooked. Goal 15c sees that increasing the capacity of local communities to pursue sustainable livelihood opportunities as a way to combat poaching and trafficking of protected species, indirectly insinuating that local communities are the main culprits of wildlife crime and biodiversity loss in general. Moreover, this recommendation is quite top-down and one-dimensional, failing to acknowledge the agency of local communities as well as the complexity of forest livelihoods in an era of global environmental change mostly facilitated by anthropogenic activities. Work, therefore, needs to be done in disseminating the transdisciplinary approach employed in this research to practitioners and decision makers in natural resource management.

9.2 Giant honey bee modeling with identification of plants

The participatory mapping of honey bee nests can be replicated in other areas of the community forest with giant honey bees and the data gathered can be added to the baseline map presented in Chapter 4 to become a basis for species distribution and abundance modeling (SDM and SAM). In parallel, a taxonomical identification of nectar sources and nesting trees only identified by common and local names in Chapter 3 should be conducted and cross-referenced with the pollen identified through melissopalynology. The phenological characteristics of the identified nectar sources and nesting trees can then be analyzed with the results of the SDM and SAM of the giant honey bees to establish carrying capacity and honey production patterns of giant honey bees and provide better recommendations for conservation and, if needed, restoration or reforestation.

9.3 Modeling impacts of a changing climate on plant phenology

In 2016, the year after the field work was conducted, the giant honey bees did not produce honey. The Tagbanua community pointed to the extreme summer heat as drying up the nectar of the giant honey bees' floral resources. Following the previous recommendation on taxonomical identification of plants, it would be tremendously valuable to model scenarios of plant phenology under varying temperatures. Coupled with real-time meteorological data (for e.g. the El Niño Southern Oscillation), this can inform honey hunter and gatherers of the potential productivity of incoming honey seasons.

9.4 Analysis of real farm gate price and occupational risks

The farm gate price of honey combs should be reviewed and incorporate labor costs of the wild honey hunter-gatherers. Moreover, the occupational risks of wild honey gathering should be evaluated by insurance underwriting. Conducting these would entail collaboration with economists and actuarial scientists. Preliminary consultation with an actuarial scientist generated data gathering strategies, which can be conducted through desktop research or field interviews. Completing this piece of research can make the case for better prices of wild honey (natural capital) and increased protection of wild honey hunters (human capital).

9.5 Understanding Tagbanua ecological anthropology

The participatory mapping of giant honey bee nests also allowed community members to take photos of different subjects (e.g. people, trees, other animals) during wild honey hunting in the forest. The photovoice approach, also known as participant-employed photography, could be employed in analyzing the photographs to understand the typology of subjects the Tagbanuas find interesting enough to capture through the lens of a camera. Results of this inquiry would be helpful in contextualizing current management practices of wild honey hunters and gatherers. As a reflexive process, the resulting analysis may also include insights from the researcher.

The outstanding research questions show the need for multiple disciplines to come together in addressing development issues. This also has the benefit of incorporating a systems approach. As this dissertation shows, ecological changes and social changes in SES are highly connected. This compels researchers and practitioners to adopt a perspective that is not focused on only either ecological or social system. It calls for a systems perspective that looks at both systems and their dynamics. As this dissertation comes to a close, it also opens opportunities for sustained engagement on indigenous rural development, forest protection, and wild honey bee conservation. This section provides several opportunities for both development researchers and practitioners to be involved by addressing the outstanding research questions identified.

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11 Appendices

Appendix I: Tools used in assessing ecosystem services from wild honey bees across social contexts (Chapter 2)

Search string used in Scopus

TITLE-ABS-KEY ("wild bees" OR "non-apis" OR "bumble bees" OR "solitary bees" OR "social bees" OR "stingless bees" OR bombus OR osmia OR andrena OR apis OR wax OR honey AND community OR livelihoo* OR soci* OR econ* OR "well being" OR cultural OR benefit OR value) AND LANGUAGE (english) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re") OR LIMIT-TO (DOCTYPE , "ip")) AND (EXCLUDE (SUBJAREA , "BIOC")) AND (EXCLUDE (SUBJAREA , "CHEM")) AND (EXCLUDE (SUBJAREA , "CENG")) AND (EXCLUDE (SUBJAREA , "PHYS")) AND (LIMIT-TO (LANGUAGE , "English"))

Table 11.1 List of publications. The following publications were reviewed for ecosystem service benefits from wild honey bees across social contexts.

Authors	Year	Title
Abebaw D et al.	2012	Dry forest based livelihoods in resettlement areas of Northwestern Ethiopia
Alves RRN et al.	2012	Traditional uses of medicinal animals in the semi-arid region of northeastern Brazil
Anderson PN	2001	Community-based conservation and social change amongst South Indian honey-hunters: An anthropological perspective
Appiah M et al.	2009	Dependence on forest resources and tropical deforestation in Ghana
Becchetti L et al.	2013	The effect of fair trade affiliation on child schooling: Evidence from a sample of Chilean honey producers
Chellappandian M et al.	2014	Documentation and quantitative analysis of local ethnozoological knowledge among traditional healers of Theni district, Tamil Nadu, India
Croitoru L	2007	Valuing the non-timber forest products in the Mediterranean region
De Carvalho RMA et al.	2014	Meliponiculture in Quilombola communities of Ipiranga and Gurugi, Paraiba state, Brazil: An ethnoecological approach
Demps K et al.	2012	Social learning across the life cycle: Cultural knowledge acquisition for honey collection among the Jenu Kuruba, India
Dos Santos GM, Antonini Y	2008	The traditional knowledge on stingless bees (Apidae: Meliponinae) used by the Enawene-Nawe tribe in western Brazil
Elolemy AT, Albedah AMN	2012	Public knowledge, attitude and practice of complementary and alternative medicine in Riyadh region, Saudi Arabia
Focho DA et al.	2009	Ethnobotanical survey of trees in Fundong, Northwest Region, Cameroon
Getzner M, Islam MS	2013	Natural resources, livelihoods, and reserve management: A case study from Sundarbans mangrove forests, Bangladesh
Gubbi S, MacMillan DC	2008	Can non-timber forest products solve livelihood problems? A case study from Periyar Tiger Reserve, India
Hart TB, Hart JA	1986	The ecological basis of hunter-gatherer subsistence in African Rain Forests: The Mbuti of Eastern Zaire
Hussain SA, Badola R	2010	Valuing mangrove benefits: Contribution of mangrove forests to local livelihoods in Bhitarkanika Conservation Area, East Coast of India
Joshi SR, Gurung MB	2005	Non-destructive method of honey hunting
Julier HE, Roulston TH	2009	Wild bee abundance and pollination service in cultivated pumpkins: Farm management, nesting behavior and landscape effects

Klein AM et al.	2003	Pollination of Coffea canephora in relation to local and regional agroforestry management
Kujawska M et al.	2012	Honey-based mixtures used in home medicine by nonindigenous population of Misiones, Argentina
Lawton RM	1982	Natural resources of Miombo woodland and recent changes in agricultural and land-use practices
Mabulla AZP	2007	Hunting and foraging in the Eyasi Basin, northern Tanzania: Past, present and future prospects
Melaku E et al.	2014	Non-timber forest products and household incomes in Bonga forest area, southwestern Ethiopia
Mootoosamy A, Fawzi Mahomoodally M	2014	A quantitative ethnozoological assessment of traditionally used animal-based therapies in the tropical island of Mauritius
Morrison M, Shepard E	2013	The archaeology of culturally modified trees: Indigenous economic diversification within colonial intercultural settings in Cape York Peninsula, northeastern Australia
Motzke I et al.	2015	Pollination mitigates cucumber yield gaps more than pesticide and fertilizer use in tropical smallholder gardens
Mulyoutami E et al.	2009	Local knowledge and management of simpukng (forest gardens) among the Dayak people in East Kalimantan, Indonesia
Negash M	2007	Trees management and livelihoods in Gedeo's agroforests, Ethiopia
Okoye CU, Agwu AE	2008	Factors affecting agroforestry sustainability in bee endemic parts of Southeastern Nigeria
Oldroyd BP, Nanork P	2009	Conservation of Asian honey bees
Vit P et al.	2015	Meliponini biodiversity and medicinal uses of pot-honey from El Oro province in Ecuador
Politis GG	1996	Moving to produce: Nukak mobility and settlement patterns in Amazonia
Potter A, LeBuhn G	2015	Pollination service to urban agriculture in San Francisco, CA
Reyes-González A et al.	2014	Diversity, local knowledge and use of stingless bees (Apidae: Meliponini) in the municipality of Nocupétaro, Michoacan, Mexico
Shackleton C, Shackleton S	2004	The importance of non-timber forest products in rural livelihood security and as safety nets: A review of evidence from South Africa
Shackleton S et al.	2011	Opportunities for enhancing poor women's socioeconomic empowerment in the value chains of three African non-timber forest products (NTFPs)
Stearman AM et al.	2008	Stradivarius in the jungle: Traditional knowledge and the use of "black beeswax" among the Yuqui of the Bolivian Amazon
Suresh Kumar M et al.	2012	Traditional beekeeping of stingless bee (Trigona sp) by Kani tribes of Western Ghats, Tamil Nadu, India
Tan NQ, Ha DT	2002	Socio-economic factors in traditional rafter beekeeping with *Apis* dorsata in Vietnam
Uddin MS et al.	2013	Economic valuation of provisioning and cultural services of a protected mangrove ecosystem: A case study on Sundarbans Reserve Forest, Bangladesh
Wakjira DT, Gole TW	2007	Customary forest tenure in southwest Ethiopia
Waring C, Jump DR	2004	Rafter beekeeping in Cambodia with *Apis dorsata*
Wood BM, Marlowe FW	2013	Household and Kin Provisioning by Hadza Men
Wood BM et al.	2014	Mutualism and manipulation in Hadza-honeyguide interactions
Yoder LSM	2011	Political ecologies of wood and wax: Sandalwood and beeswax as symbols and shapers of customary authority in the Oecusse enclave, Timor
Youn YC	2009	Use of forest resources, traditional forest-related knowledge and livelihood of forest dependent communities: Cases in South Korea

Appendix II: Data on spatial and statistical analyses on ecological changes and local knowledge shifts in the Tagbanua honey hunting community (Chapter 5)

GPS Coordinates: ________________ **Voice file:** __________________ **Control number:** _________

Assessment of institutional knowledge on wild honey bees (*Apis dorsata*) in Aborlan, Palawan, Philippines

Name of data collector: Denise Margaret Matias

Date: ________________________________

Start time: _________ End time: _________

GENERAL INFORMATION

1. Name of respondent:

____

2. Indigenous? YES – NO

2.1. If yes, which tribe? ______________________

3. Gender: Male – Female

4. Position:

____

5. Number of years in service in current position:

____

____

REGULATIONS & INSTITUTIONS

6. Are you aware of any government or organizational regulations about the harvesting of wild honey? YES – NO

6.1. If yes, what are these regulations?

____

____

____

____

____

____

____

6.2. Is your agency involved in implementing any of these regulations? YES – NO

6.2.1. If yes, how are you involved?

____

____

____

____

____

6.2.2. Are there penalties for non-compliance with these regulations? YES – NO

6.2.2.1. If yes, what are they?

____

____

____

____

____

6.2.3. Do you also work with other agencies or organizations in implementing these regulations? YES – NO

6.2.3.1. If yes, who are these agencies or organizations?

____

____

1

Figure 11.1 Questionnaire used to assess institutional knowledge on giant honey bees and resource management. After field testing the questionnaire, this was the final version used in the interview.

GPS Coordinates: ________________ Voice file: __________________ Control number: _________

____

____

____

6.2.2.2. What is the nature of your collaboration?

____

____

____

____

____

6.3. In your opinion, is this an effective way to manage honey harvesting?

____

____

____

____

____

7. Are you aware of any international regulations about the harvesting of wild honey? YES – NO

7.1. If yes, what are these regulations?

____

____

____

____

____

8. Do you think these regulations are enough for sustainability of wild honey bees? YES – NO

8.1. If no, what do you think should be done to sustain existence of wild honey bees?

____

____

____

____

____

9. Other comments

____

____

____

____

____

HONEYBEES

10. Are you familiar with how wild honey is gathered? YES – NO

10.1. If yes, please narrate the process.

____

____

____

____

____

____

____

2

GPS Coordinates: ________________ Voice file: ________________ Control number: __________

11. Have you personally witnessed a wild honey gathering? YES – NO

11.1. If yes, where? ____________________________

____

____

____

____

12. Have you eaten bee larvae? YES – NO

13. What about pollen? YES – NO

14. Do you know which time of the year can they be seen? YES – NO

14.1. If yes, when?

____

____

____

____

15. Do you know where they can usually be seen? YES – NO

15.1. If yes, where?

____

____

____

____

____

16. Do you know what their favourite nesting trees are? YES – NO

16.1. If yes, what are these?

____

____

____

____

____

____

17. Do you know which flowers do they often visit? YES – NO

17.1. If yes, which ones?

____

____

____

____

____

18. Do you recognize any of the bees in the illustration? If yes, which are they? ______________

____

____

____

____

____

3

GPS Coordinates: ________________ Voice file: __________________ Control number: _________

Assessment of local community knowledge, attitudes, and practices (KAP) on wild honey bees (*Apis dorsata*) in Aborlan, Palawan, Philippines

Name of data collector: Lenita Nangcod OR Denise Margaret Matias

Date: ________________________________

Start time: _________ End time: _________

GENERAL INFORMATION

1. Name of respondent:

____

2. Indigenous or not? YES – NO – MIXED

3. How long living in the community? ______

4. Gender: Male – Female

5. Age: ______________________________

6. Marital status: Married – Single – Widow – Co-habitation

6. Relative who is a hunter gatherer: YES – NO

7. Role in the household:

____

8. Role/s in the community (if any):

____

____

9. Did you attend school: YES – NO

9.1. If yes, how long: _______________________

9.2. If no, are you able to read and write? YES – NO

INFORMATION ON HONEYBEES

10. Do you recognize any of the bees in the illustration? If yes, which are they? ______________

____

____

11. Which time of the year do you see them?

____

____

12. Where do you see them?

____

____

13. Which trees do they nest on?

____

____

14. Which flowers do they often visit?

____

____

15. Does your household still consume honey? If yes, how much? _______________________________

____

16. When do you use it (e.g. medicine, staple food)?

____

____

____

17. Have you eaten bee larvae? YES – NO

1

Figure 11.2 Questionnaire used to assess knowledge on giant honey bees and resource management. This is the English version of the actual questionnaire used. After field testing, this was the final version used in the survey.

GPS Coordinates: ________________ Voice file: __________________ Control number: _________

18. Are you aware of any government regulations about the harvesting of honey? YES – NO

____

____

____

____

HOUSEHOLD INFORMATION

19. Household size (number of people eating and sleeping in the house): ____________________

20. Assets owned by household (e.g. house and lot, store, land, others): ___________________________

____

____

20.1. If your household owns land, how are they used?

____

____

____

20.1.1. If farmed or planted, what kind of crops?

____

____

____

20.1.1.1. Do you use pesticides? If yes, what kind?

____

____

____

____

____

20.1.1.2. Do you use fertilizers? If yes, what kind?

____

____

____

____

20.1.1.3. Do you keep farm animals? If yes, what kind?

____

____

____

____

____

21. Are any of these used for business purposes? If yes, which ones? ______________________________

____

____

____

22. Do you farm the land yourself? Yes – No

22.1. If not, what off-farm activities do you do?

____

____

____

____

____

____

2

Table 11.2 Data of satellite images analyzed. Satellite images with minimal cloud cover were analyzed.

Date of image	Cloud cover	Satellite
1988-June-30	2.00	Landsat 5 TM
1998-January-17	0.00	Landsat 5 TM
2004-February-03	5.00	Landsat 5 TM
2015-May-24	5.48	Landsat 8 OLI/TIRS

Table 11.3 Results of repeated measures ANOVA for community households

Determinant of the correlation matrix Det = 0.902 Bartlett test of sphericity Chi-square = 100.996 Degrees of freedom = 1 p-value = 0.000 H0: variables are not intercorrelated Kaiser-Meyer-Olkin Measure of Sampling Adequacy KMO = 0.500			Number of obs = 984 R-squared = 0.8035 Root MSE = .090254 Adj R-squared = 0.7372		
Source	Partial SS	df	MS	F	Prob>F
Model	24.486284	248	.09873502	12.12	0.0000
id	18.559701	245	.07575388	9.30	0.0000
time	5.9265828	3	1.9755276	242.52	0.0000
Residual	5.9870947	735	.00814571		
Total	30.473378	983	.03100038		
Between-subjects error term: id Levels: 246 (245 df) Lowest b.s.e. variable: id Repeated variable: time			Huynh-Feldt epsilon = 0.7711 Greenhouse-Geisser epsilon = 0.7635 Box's conservative epsilon = 0.3333		

			----------------------- Prob > F -----------------------			
Source	df	F	Regular	H-F	G-G	Box
time	3	242.52	0.0000	0.0000	0.0000	0.0000
Residual	735					

Table 11.4 Results of repeated measures ANOVA for giant honey bee nesting areas

Determinant of the correlation matrix Det = 0.783 Bartlett test of sphericity Chi-square = 29.713 Degrees of freedom = 1 p-value = 0.000 H0: variables are not intercorrelated Kaiser-Meyer-Olkin Measure of Sampling Adequacy KMO = 0.500			Number of obs = 124 R-squared = 0.5155 Root MSE = .135509 Adj R-squared = 0.3378		
Source	Partial SS	df	MS	F	Prob>F
Model	1.758168	33	.05327782	2.90	0.0000
id	.98341585	30	.03278053	1.79	0.0192
time	.77475211	3	.2582507	14.06	0.0000
Residual	1.6526425	90	.01836269		
Total	3.4108105	123	.02773017		
Between-subjects error term: id Levels: 31 (30 df) Lowest b.s.e. variable: id Repeated variable: time			Huynh-Feldt epsilon = 0.5263 Greenhouse-Geisser epsilon = 0.5051 Box's conservative epsilon = 0.3333		

			----------------------- Prob > F -----------------------			
Source	df	F	Regular	H-F	G-G	Box
time	3	14.06	0.0000	0.0001	0.0001	0.0008
Residual	90					

Table 11.5 Results of mixed-effects linear regression for community households

Mixed-effects ML regression Group variable: id Log likelihood = 717.90805			Number of obs = 984 Number of groups = 246 Obs per group: min = 4 avg = 4.0 max = 4 Wald chi2(1) = 742.02 Prob > chi2 = 0.0000			
ndvi	Coef.	Std. Err.	z	P>|z|	Normal-based [95% Conf. Interval]	
time	-.0609634	.002238	-27.24	0.000	-.0653498	-.0565769
_cons	.6530448	.0108823	60.01	0.000	.6317158	.6743738
Random-effects Parameters			Estimate	Std. Err.	Normal-based [95% Conf. Interval]	
id: (empty)						
Residual: Unstructured						
var(e1)			.022801	.0021941	.0188818	.0275336
var(e2)			.0698213	.0073212	.0568505	.0857515
var(e3)			.0224634	.0021397	.0186379	.027074
var(e4)			.0135204	.0013746	.0110778	.0165016
cov(e1,e2)			.0273897	.0039749	.019599	.0351804
cov(e1,e3)			.0174372	.00196	.0135957	.0212787
cov(e1,e4)			.0121829	.0015129	.0092176	.0151481
cov(e2,e3)			.0302459	.0037755	.022846	.0376458
cov(e2,e4)			.0195351	.0030187	.0136186	.0254517
cov(e3,e4)			.0121058	.0015023	.0091612	.0150503
LR test vs. linear model: chi2(9) = 707.86 Prob > chi2 = 0.0000						
Note: The reported degrees of freedom assumes the null hypothesis is not on the boundary of the parameter space. If this is not true, then the reported test is conservative.						

Table 11.6 Results of mixed-effects linear regression for giant honey bee nesting areas

Mixed-effects ML regression Group variable: id Log likelihood = 102.44415			Number of obs = 124 Number of groups = 31 Obs per group: min = 4 avg = 4.0 max = 4 Wald chi2(1) = 49.97 Prob > chi2 = 0.0000			
ndvi	Coef.	Std. Err.	z	P>|z|	Normal-based [95% Conf. Interval]	
time	-.0581223	.0082222	-7.07	0.000	-.0742375	-.042007
_cons	.6505632	.022092	29.45	0.000	.6072636	.6938628
Random-effects Parameters			Estimate	Std. Err.	Normal-based [95% Conf. Interval]	
id: (empty)						
Residual: Unstructured						
var(e1)			.0179562	.004588	.0108823	.0296282
var(e2)			.0057258	.0014687	.0034634	.0094662
var(e3)			.0515942	.0131439	.0313151	.0850058

var(e4)	.0119997	.0030659	.0072726	.0197995
cov(e1,e2)	.0002836	.0018241	-.0032916	.0038588
cov(e1,e3)	-.0089664	.0057349	-.0202066	.0022738
cov(e1,e4)	-.0026858	.002701	-.0079796	.0026081
cov(e2,e3)	.0111827	.0037248	.0038823	.0184831
cov(e2,e4)	.0038009	.0016528	.0005615	.0070403
cov(e3,e4)	.0172278	.0055004	.0064473	.0280083
LR test vs. linear model: chi2(9) = 80.89 Prob > chi2 = 0.0000				
Note: The reported degrees of freedom assumes the null hypothesis is not on the boundary of the parameter space. If this is not true, then the reported test is conservative.				

Appendix III. Supplementary material to policy recommendation (Chapter 7)

Table 11.7 List of publications. The following were reviewed for their use of the word "honey bee"

Authors	Year	Title
Doublet V et al.	2016	Bees under stress: sublethal doses of a neonicotinoid pesticide and pathogens interact to elevate honey bee mortality across the life cycle
Ronai I et al.	2016	Anarchy Is a Molecular Signature of Worker Sterility in the Honey Bee
Schwarz RS et al.	2016	Early gut colonizers shape parasite susceptibility and microbiota composition in honey bee workers
Ashby R et al.	2016	MicroRNAs in Honey Bee Caste Determination
Schmuck R, Lewis G	2016	Review of field and monitoring studies investigating the role of nitro-substituted neonicotinoid insecticides in the reported losses of honey bee colonies (*Apis mellifera*)
Tehel et al.	2016	Impact of managed honey bee viruses on wild bees
Natsoupoulou ME et al.	2016	European isolates of the Microsporidia *Nosema apis* and *Nosema ceranae* have similar virulence in laboratory tests on European worker honey bees
Gibson JD, Hunt GJ	2016	The complete mitochondrial genome of the invasive Africanized Honey Bee, *Apis mellifera scutellata* (Insecta: Hymenoptera: Apidae)
Giacobina A et al.	2016	Fumagillin control of *Nosema ceranae* (Microsporidia: Nosematidae) infection in honey bee (Hymenoptera: Apidae) colonies in Argentina
Sánchez-Bayo F et al.	2016	Are bee diseases linked to pesticides?—A brief review
Chhakchhuak L et al.	2016	The near complete mitochondrial genome of the Giant honey bee, *Apis dorsata* (Hymenoptera: Apidae: Apinae) and its phylogenetic status
Maeda T	2016	Effects of tracheal mite infestation on Japanese honey bee, *Apis cerana japonica*
Pettis JS et al.	2016	Colony Failure Linked to Low Sperm Viability in Honey Bee (*Apis mellifera*) Queens and an Exploration of Potential Causative Factors
DeGrandi-Hoffman G et al.	2016	Honey bee colonies provided with natural forage have lower pathogen loads and higher overwinter survival than those fed protein supplements
David A et al.	2016	Widespread contamination of wildflower and bee-collected pollen with complex mixtures of neonicotinoids and fungicides commonly applied to crops
Kešnerová L et al.	2016	*Bartonella apis* sp. nov., a honey bee gut symbiont of the class Alphaproteobacteria
Cavigli I et al.	2016	Pathogen prevalence and abundance in honey bee colonies involved in almond pollination
Tan J et al.	2016	No impact of DvSnf7 RNA on honey bee (*Apis mellifera* L.) adults and larvae in dietary feeding tests
Ostwald MM et al.	2016	The behavioral regulation of thirst, water collection and water storage in

		honey bee colonies
Park MG et al.	2016	Per-visit pollinator performance and regional importance of wild *Bombus* and *Andrena* (Melandrena) compared to the managed honey bee in New York apple orchards
Rader R et al.	2016	Non-bee insects are important contributors to global crop pollination
Wilfert L et al.	2016	Deformed wing virus is a recent global epidemic in honeybees driven by Varroa mites
Galbraith DA et al.	2016	Testing the kinship theory of intragenomic conflict in honey bees (*Apis mellifera*)
McMahon DP et al.	2016	Elevated virulence of an emerging viral genotype as a driver of honeybee loss
Hu P et al.	2016	Complete mitochondrial genome of the Algerian honeybee, *Apis mellifera intermissa* (Hymenoptera: Apidae)
Klein C, Barrow AB	2016	Insects have the capacity for subjective experience
Frias BED et al.	2016	Pollen nutrition in honey bees (*Apis mellifera*): impact on adult health
Hladik ML et al.	2016	Exposure of native bees foraging in an agricultural landscape to current-use pesticides
Moritz RFA, Erler S	2016	Lost colonies found in a data mine: Global honey trade but not pests or pesticides as a major cause of regional honeybee colony declines
Kapheim KM	2016	Genomic sources of phenotypic novelty in the evolution of eusociality in insects
Libbrecht R et al.	2016	Robust DNA Methylation in the Clonal Raider Ant Brain
Kwong WK, Moran NA	2016	*Apibacter adventoris* gen. nov., sp. nov., a member of the phylum Bacteroidetes isolated from honey bees
McLoone P et al.	2016	Honey: A realistic antimicrobial for disorders of the skin
Eimanifar A et al.	2016	The complete mitochondrial genome of the Cape honey bee, *Apis mellifera capensis* Esch. (Insecta: hymenoptera: apidae)
Calatayud-Vernich P et al.	2016	Influence of pesticide use in fruit orchards during blooming on honeybee mortality in 4 experimental apiaries
Codling G et al.	2016	Concentrations of neonicotinoid insecticides in honey, pollen and honey bees (*Apis mellifera* L.) in central Saskatchewan, Canada
Blitzer EJ et al.	2016	Pollination services for apple are dependent on diverse wild bee communities
Amakpe F et al.	2016	Discovery of Lake Sinai virus and an unusual strain of acute bee paralysis virus in West African apiaries
Gaines-Day H, Gratton C	2016	Crop yield is correlated with honey bee hive density but not in high-woodland landscapes
Rodrigues M, Flatt T	2016	Endocrine uncoupling of the trade-off between reproduction and somatic maintenance in eusocial insects
Charbonneau L et al.	2016	Effects of *Nosema apis*, *N. ceranae*, and coinfections on honey bee (*Apis mellifera*) learning and memory
Corby-Harris V et al.	2016	*Parasaccharibacter apium*, gen. nov., sp. nov., Improves Honey Bee (Hymenoptera: Apidae) Resistance to Nosema
Mogren CL, Lundgren JG	2016	Neonicotinoid-contaminated pollinator strips adjacent to cropland reduce honey bee nutritional status
He XJ et al.	2016	Starving honey bee (*Apis mellifera*) larvae signal pheromonally to worker bees
Brandt et al.	2016	The neonicotinoids thiacloprid, imidacloprid, and clothianidin affect the immunocompetence of honey bees (*Apis mellifera* L.)
Sanders ME et al.	2016	Pollinators, pests, and predators: Recognizing ecological trade-offs in agroecosystems
Evison SEF et al.	2016	Innate expression of antimicrobial peptides does not explain genotypic diversity in resistance to fungal brood parasites in the honey bee
Hendriksma HP, Shafir S	2016	Honey bee foragers balance colony nutritional deficiencies
Kakamanu ML et al.	2016	Honey Bee Gut Microbiome Is Altered by In-Hive Pesticide Exposures
Wilson ME et al.	2016	Using Nonmetric Multidimensional Scaling to Analyze Bee Visitation in East

		Tennessee Crops as an Indicator of Pollination Services Provided by Honey Bees (*Apis mellifera* L.) and Native Bee
Kilaso M et al.	2016	No evidence that DNA methylation is associated with the regulation of fertility in the adult honey bee *Apis mellifera* (Hymenoptera: Apidae) worker ovary
Li-Byarlay He et al.	2016	Honey bee (*Apis mellifera*) drones survive oxidative stress due to increased tolerance instead of avoidance or repair of oxidative damage
Eyer M et al.	2016	No spatial patterns for early nectar storage in honey bee colonies
Peng Y, Yang E	2016	Sublethal Dosage of Imidacloprid Reduces the Microglomerular Density of Honey Bee Mushroom Bodies
Krainer S et al.	2016	Effect of hydroxymethylfurfural (HMF) on mortality of artificially reared honey bee larvae (*Apis mellifera carnica*)
Koh I et al.	2016	Modeling the status, trends, and impacts of wild bee abundance in the United States
Hladun KR et al.	2016	Metal contaminant accumulation in the hive: Consequences for whole-colony health and brood production in the honey bee (*Apis mellifera* L.)
Desai SD et al.	2016	Occurrence, detection, and quantification of economically important viruses in healthy and unhealthy honey bee (Hymenoptera: Apidae) colonies in Canada
Sturm S et al.	2016	Agatoxin-like peptides in the neuroendocrine system of the honey bee and other insects
Smith ML et al.	2016	Honey bee sociometry: tracking honey bee colonies and their nest contents from colony founding until death
Carrillo-Tripp J et al.	2016	In vivo and in vitro infection dynamics of honey bee viruses
Gómez-Ramos MM	2016	Screening of environmental contaminants in honey bee wax comb using gas chromatography–high-resolution time-of-flight mass spectrometry
Nazzi F, Le Conte Y	2016	Ecology of Varroa destructor, the Major Ectoparasite of the Western Honey Bee, *Apis mellifera*
Mordecai GJ et al.	2016	Diversity in a honey bee pathogen: first report of a third master variant of the Deformed Wing Virus quasispecies
Smart MD et al.	2016	Land use in the Northern Great Plains region of the U.S. influences the survival and productivity of honey bee colonies
Anderson KE et al.	2016	Ecological Succession in the Honey Bee Gut: Shift in Lactobacillus Strain Dominance During Early Adult Development
Remnant EJ et al.	2016	Parent-of-origin effects on genome-wide DNA methylation in the Cape honey bee (*Apis mellifera capensis*) may be confounded by allele-specific methylation
Campbell EM et al.	2016	Transcriptome analysis of the synganglion from the honey bee mite, Varroa destructor and RNAi knockdown of neural peptide targets
Holt HL, Grozinger CM	2016	Approaches and Challenges to Managing Nosema (Microspora: Nosematidae) Parasites in Honey Bee (Hymenoptera: Apidae) Colonies
Urlacher E et al.	2016	Honey Bee Allatostatins Target Galanin/Somatostatin-Like Receptors and Modulate Learning: A Conserved Function?
Rolke D et al.	2016	Large-scale monitoring of effects of clothianidin-dressed oilseed rape seeds on pollinating insects in Northern Germany: effects on honey bees (*Apis mellifera*)
Xie X et al.	2016	Why do Varroa mites prefer nurse bees?
Chapman NC et al.	2016	Hybrid origins of Australian honeybees (*Apis mellifera*)
Barr M et al.	2016	Unlocking new contrast in a scanning helium microscope
Guedes RN et al.	2016	Pesticide-Induced Stress in Arthropod Pests for Optimized Integrated Pest Management Programs
Corona M et al.	2016	Molecular mechanisms of phenotypic plasticity in social insects
Kalia P et al.	2016	Effect of propolis extract on hematotoxicity and histological changes induced by *Salmonella enterica* serovar Typhimurium in BALB/c mice
Chuttong B et al.	2016	Physicochemical profiles of stingless bee (Apidae: Meliponini) honey from South East Asia (Thailand)
Silici S et al.	2016	Honeybees and honey as monitors for heavy metal contamination near

		thermal power plants in Mugla, Turkey
Maleszka R	2016	Epigenetic code and insect behavioural plasticity
Wang Y et al.	2016	Starvation stress during larval development facilitates an adaptive response in adult worker honey bees (*Apis mellifera* L.)
Sobotka JA et al.	2016	Structure and function of gene regulatory networks associated with worker sterility in honeybees
Walling LL, Kaloshian I	2016	Plant-Herbivore Interactions in the Era of Big Data
Ostroverkhova NV et al.	2016	Investigation of polyandry in honey bees (*Apis mellifera*) using microsatellites
Noor MJ et al.	2016	A review of the pollen analysis of South Asian honey to identify the bee floras of the region
Wedd L et al.	2016	Differentially methylated obligatory epialleles modulate context-dependent LAM gene expression in the honeybee *Apis mellifera*
El-Sheshtawy RI et al.	2016	Natural honey as a cryoprotectant to improve Arab stallion post-thawing sperm parameters
Parmentier L et al.	2016	Plasticity in the gut microbial community and uptake of Enterobacteriaceae (Gammaproteobacteria) in *Bombus terrestris* bumblebees' nests when reared indoors and moved to an outdoor environment
Rueppell O et al.	2016	Ties between ageing plasticity and reproductive physiology in honey bees (*Apis mellifera*) reveal a positive relation between fecundity and longevity as consequence of advanced social evolution
Smith TJ, Sanders ME	2016	Honey bees: the queens of mass media, despite minority rule among insect pollinators
Dötterl S et al.	2016	Ozone Differentially Affects Perception of Plant Volatiles in Western Honey Bees
Heimbach F et al.	2016	Large-scale monitoring of effects of clothianidin dressed oilseed rape seeds on pollinating insects in Northern Germany: implementation of the monitoring project and its representativeness
Graystock P et al.	2016	The effects of single and mixed infections of *Apicystis bombi* and deformed wing virus in *Bombus terrestris*
Santiago LR et al.	2016	Genetic variability in captive populations of the stingless bee *Tetragonisca angustula*
Peso M et al.	2016	Physiology of reproductive worker honey bees (*Apis mellifera*): insights for the development of the worker caste
Wang Y et al.	2016	Larval starvation improves metabolic response to adult starvation in honey bees (*Apis mellifera* L.)
Bargańska Ż et al.	2016	Honey bees and their products: Bioindicators of environmental contamination
Naeger NL, Robinson GE	2016	Transcriptomic analysis of instinctive and learned reward-related behaviors in honey bees
Jack CJ et al.	2016	Effects of pollen dilution on infection of *Nosema ceranae* in honey bees
Bisson LF et al.	2016	The two faces of *Lactobacillus kunkeei*: Wine spoilage agent and bee probiotic

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I first learned about ZEF in 2010 when I was an Alexander von Humboldt Foundation International Climate Protection Fellow at Germanwatch and a co-fellow was hosted by ZEFb. When I was about to finish my fellowship at Germanwatch, a colleague told me to apply to ZEF's doctoral program. Before I can do that, I needed to get my master's degree first. I spent almost a year studying a master's degree at the Central European University in Hungary; four days after submitting my master's dissertation, I flew straight back to Asia, determined to apply to ZEF despite having only a month left to put together an application. I sought the recommendation of Ziaul Hassan as well as Christoph Bals and Renato Redentor Constantino, both of whom were busy Executive Directors of their respective organizations but were ready to provide my request at short notice. Two months later, I got an email from Prof. Alexandra Klein, with Prof. Henrik von Wehrden in copy, regarding my inquiry for PhD supervision that is a prerequisite for an application to another DAAD scholarship. Both were initially reluctant since the application deadline was two weeks away; nonetheless, I was able to book an interview with Henrik and his then-PhD student Fabienne Gralla two days after initial correspondence. He agreed to supervise me and I was able to submit another application to DAAD through the German Embassy in the Philippines. For this application, I am grateful to Rowena Boquiren, Prof. László Pintér, and Brandon Anthony for providing recommendations. The decisions on the two scholarships were a long wait and I became busy working for The Munden Project (now TMP Systems) under the mentorship of Lou Munden. I was enjoying my work too much that I decided I would no longer apply to other PhD programs and leave the two applications to fate. I thought I didn't get into ZEF, but as Günther Manske said at the beginning of 2013, "You are lucky…." I was waiting for word on my other DAAD application, but the DAAD scholarship at ZEF couldn't wait. I told Henrik that I would be accepting the ZEF offer and he graciously said that he could still supervise me anyway. Telling that to Henrik after all the disturbance I caused was already hard enough, but it was harder to tell Lou since he counted on me; in the end, we reached a compromise and I am really thankful for the support he has given me. Fast forward to August 2013, I had the pleasure to meet Maike Retat-Amin as well as fellow DAAD scholars at ZEF, some of whom like Willis Okumu would become great support pals during the disciplinary course at ZEFa. I got to know other classmates like Jiaxin Tan and Helena Cermeño and ZEF senior researchers like Saravanan Subramanian, Hart Feuer, Katja Mielke, Till Stellmacher, and Guido Lüchters during this time. Till became my tutor, while Guido and Jiaxin became really good friends of mine. At the corridors of ZEF, I had the chance to meet Grace Villamor; we met in 2007 when I applied for her position in her former organization when she was about to leave for her PhD at ZEF. I reminded her about that and she remembered why I didn't get the job; my activist background didn't seem suitable for a research position! I knew that beforehand, but I also knew there was no real harm in trying. I tried to fit into ZEFa with a natural science background, but Prof. Solvay Gerke eventually recommended that I move to ZEFc, which just freshly welcomed Prof. Christian Borgemeister as its director. It was a blessing in disguise; I became interested in giant honey bees during my field visits for The Munden Project and hearing the problems straight from the Tagbanuas of Sagpangan in Palawan

(Philippines) made me think twice about my initial proposal on indigenous swidden agriculture. Given his entomology specialization, Prof. Borgemeister was a perfect fit and he immediately introduced me to former colleagues at ICIPE (Kenya) and to Andreé Hamm of INRES (Bonn). I had my introduction to the European honey bee by Dete Papendieck and, even if it was a different species, I learned a lot. They also brought me to the *Bienentagung*, where I had the honor to meet Asian honey bee experts Prof. Nikolaus and Dr. Gudrun Koeniger. The Koenigers even gave me a free copy of their book "Honey bees in Borneo," which will forever remain an important book to me! I also met Alexis Beaurepaire who patiently answered my questions on giant honey bees. In parallel, I was also corresponding with NTFP-EP Asia and Philippine folks like Tanya Conlu and Ruth Canlas to shape my research questions and facilitate an introduction to NATRIPAL. After completing administrative requirements at ZEF, I went to the field in 2014. It was the start of what would be a substantial contribution of my parents; Edna and Saturnino Matias provided much-needed logistical assistance by always picking me up and dropping me off at airports or to meetings in Metro Manila. My first visit to Palawan was to (1) attend the Beenet Conference in Puerto Princesa (where I met Dr. Cleofas Cervancia) and (2) start my engagement with SAKTAS, NATRIPAL, NCIP, and Palawan Council for Sustainable Development, all of which help the indigenous peoples of Palawan. I am extremely grateful to Loreta Alsa, Joanne Abrina, and Mercedes Limsa of NATRIPAL, Lenita Nangcod and Anita Alsa of SAKTAS, and Manny Uy, Jr. of NTFP-EP Philippines for their help during my stay in Palawan. In Metro Manila, other NTFP-EP Asia and Philippine folks like Crissy Guerrero, Katherine Mana-Galido, Beng Camba, Femy Pinto and Erwin Diloy always made me feel at home at their office. I am thankful to them for partially sponsoring my participation at *Madhu Duniya* 2015 in Cambodia where I met *A. dorsata* expert Nguyen Quang Tan who was nice enough to accommodate my questions. I also thank my good friend Vito Hernandez, who connected me to Jun Cayron of Palawan State University Museum. Jun became my local supervisor and dropping his name made it easier to capture the attention of Leonard Soriano (our GPS trainer during the workshop where I got funding from The Eva Crane Trust) and Jovic Fabello of the Palawan Council for Sustainable Development. Tanya was also instrumental in linking me with Emil Robles who was formerly supervised by Anne-Marie Sémah who analysed the pollen content of my honey samples. Outside of field work, I had Jeanne Tabangay of CIP and Joshua Carlos to turn to in times of need in Puerto Princesa. Family and friends from all over the world kept me company whether through snail or electronic mail, virtual calls and messages. My sisters April and Kyla Matias cheer me on through our group chat with our mother. My aunts Jennifer and Jocelyn (+) Santos would also check up on me once in a while through social networks, similar to how I kept in touch with good friends Vanessa Miranda, Val and Nyel Gonzales, Donna Macalino-Guillen, Camille Dionzon, Jacob Flores, Katrina Lutap, Maia Malonzo, Ava Salvador, Ryllah Berico, Sinag de Leon, Robert Basilio, Jr., Patricia Ramirez, Teresa Paterno Park, Jennifer Castillo-Garcia, Anna Pantoja Domingo, Samantha Benedito-Rigor, Clair Moran Aliño, Aivee Escolano (who was also my courier of a copy of M.H. Venturello's manuscript all the way from New York), Jezrel Magpantay, Gil Madronero, Jr., Hanz Flores, Kaushik Ramu, Joan Ramilla Diep, Bowen Gu. Ginger Ramirez and Ivy Yu visited me in Bonn while Aurora Hipol visited me not just in Bonn but also in Puerto Princesa. I also met Antonio La Viña and Renato Redentor Constantino during their official visits to Bonn.

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